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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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THURSDAY, APRIL 15, 1920.

The Encouragement of Discovery.

DURING the past few years much has been done by the State to provide facilities for research, but it is not too much to say that even now neither the public nor our statesmen understand the debt they owe to the peculiar and rare geniuses to whom the greatest discoveries are due, or that any attempt has been made to discharge it. Grants for research expenses or for the maintenance of research workers are available from various sources, and much valuable work is being carried on through this aid. What is wanted to complete the scheme is a fund from which pensions or other substantial money grants could be made for scientific discoveries of an epoch-making character, somewhat in the manner of the award of the Nobel prizes. We referred a few weeks ago (March 4, p. 18) to a deputation which waited upon Mr. Balfour, Lord President of the Council, to urge that a sum of about 20,000*l.* should be set aside annually for this purpose; and we trust that this modest provision for the encouragement of genius will be forthcoming.

The January number of the Journal of the British Science Guild contains a carefully prepared report on the subject of awards of this nature, with particular reference to medical discovery. The committee which presented the report consisted of eleven men of scientific distinction—five representing the British Medical Association and six the British Science Guild; and the members of it formed the deputation to Mr. Balfour, with the addition of several members of the House of Commons. Two cardinal proposals were made—first, that medical discoveries, even when made accidentally and not as a result of designed investigation, should be encouraged by direct pecuniary reward; secondly, that for losses or outlays incurred by private investigators engaged in medical discovery the State should recognise the principle of compensation.

These two proposals rest on the fundamental fact that, owing to the peculiar nature of medical service and the necessity for carefully adjusted ethical sanctions, the individual medical investigator has often to sacrifice the welfare of himself and his family, although his investigation may have the highest social value. The capacity for discovery, including invention, is very unevenly distributed, but in every field of science rewards, both financial and honorary, act as powerful evocatives of faculty. In any sphere except medicine, an invention or a discovery has at least a "business" chance of bringing a direct reward, for the investigator can patent his invention or protect himself in some other way. In medicine he cannot patent a new microbe or a new method. The attempts to patent or protect serums or similar products are usually failures, and may end in the removal of a name from the register "for infamous conduct in a professional respect." Probably in this matter the medical profession is too exacting, but there are obvious good reasons for maintaining on the highest ethical level the sanctions of a profession that touch so nearly the private life of the subject. These sanctions, therefore, must continue to be a serious handicap to the medical investigator, who cannot employ the ordinary business methods to secure for himself any profit from his invention, or discovery, or new method of treatment.

If medical discovery is thus shut out from normal commercial reward, there is good ground for the view that the State should establish a system of compensation. To a certain extent, medical research is itself a career, and in the future development of medicine research will offer more and more openings for talent. But meanwhile it is certain that the medical inventor or discoverer has much less chance of making even a respectable living than the clinical medical practitioner. Of this it would be easy to give sufficient proof, but it is not seriously disputed.

Within the medical schools there are many forms of award, such as honorary degrees, money prizes, and the like; but their distribution is largely accidental. Further, the inventor or discoverer has so to specialise his energies that he may positively disqualify himself for the more lucrative administrative or clinical posts. This is more or less true of every branch of applied science, not to speak of pure science; it is overwhelmingly true of medical scientific investigation.

The joint committee and the deputation have uncovered an important scientific area where the State might well recognise a duty to compensate. How profoundly the economic motive operates to increase the production of inventions the Courts for the war awards have abundantly shown. It would be to the ultimate advantage of the State to pay for medical and other scientific discoveries which bring no financial gain to the men who made them: the method of payment is a detail and need offer no more difficulty than that involved in making other awards. The principle is so sound that it ought at once to be conceded.

English Cytology.

An Introduction to the Study of Cytology. By Prof. L. Doncaster. Pp. xiv + 280 + xxiv plates. (Cambridge: At the University Press, 1920.) Price 21*s.* net.

THE publication of this volume is to be regarded as an event in the progress of cytology. Prof. Doncaster's new book is not intended to serve as a text-book on cytology, though it contains a wealth of facts; but its aim is to interest the senior student in the subject by pointing out the way in which cytology is related to the great fundamental problems at the root of all biological research. Quite recently Paul Buchner, of Munich, published a new "Handbuch" of cytology, and it is with pride that we compare the work before us with its German prototype. A great deal of the material in Prof. Doncaster's book is new, and the work is as strictly up-to-date as is possible when one is dealing with a vast and changing subject such as cytology.

The author's conception of the cell is very broad; he recognises the important part played by the nucleus, but pays due attention to the Golgi apparatus and mitochondria, which he considers may be of special importance in the life of the cell; useful discussions on the structure of protoplasm, such as are illustrated by Hardy's work, and on Hertwig's conceptions of the "karyoplasmatic ratio," are added to this part of the book. The question of the origin and relationships of the centrosome has been treated in a masterly way, and the author shows how J. W. Jenkinson's work on the fertilisation of the Axolotl can provide a middle way between the divergent views—that centrosomes arise from pre-existing centrosomes, and that they may be formed *de novo* in the cytoplasm.

Prof. Doncaster steers a careful course through the troubled waters surrounding the various questions with regard to astral rays, spindle fibres, and "mitokinetism." He gives a fair and lucid *exposé* of the various ingenious hypotheses brought forward to explain mitotic division, but concludes that, at present at least, no really satisfactory explanation of the phenomenon of mitosis has been given.

Students of cytology are often turned away from entering into the various problems associated with the behaviour of the chromosomes in the germ-cell cycle by the fact that the whole question is obscured by a multitude of ill-digested descriptions, theories, and hypotheses. Prof. Doncaster has written an exceptionally clear and able account of the typical behaviour of the chromosomes. Never polemical, he gives a straightforward account which includes on a broad basis all the most modern work on the chromosomes. His first description of maturation is written with an eye to his later accounts of the chromosomes in sex and Mendelism, but he is careful not to confuse his preliminary survey by bringing in debatable matter. Here the student will find a conveniently introduced *résumé* of the Chiasmatypy hypothesis of Janssens, which has gained such prominence among Mendelians.

The modern work on the behaviour of the cytoplasmic inclusions during spermatogenesis has been the subject of careful descriptions. Prof. Doncaster has treated the matter in an able manner, and the worker unacquainted with the Golgi apparatus and mitochondria will find in this book a readable and accurate account of the present state of our knowledge. The various questions surrounding the formation of egg yolk are not treated at length, and should be included in a future edition; we refer especially to the work of Weigl, Hirschler, Rio Hortega, etc. The author exhibits a commendable scepticism with regard to the specificity of the so-called "chromatin" dyes, and points out in several parts of the book that cytoplasmic bodies unrelated to chromatin may stain basophil, and yet not be true chromatin.

In his chapter on segmentation Prof. Doncaster succeeds in bringing out the fact that we have really proceeded a very short distance in the elucidation of the great problems surrounding even the first stages of animal development. In a later part of the book the author discusses some of these problems.

The subject of parthenogenesis is treated at length, and the author draws freely from his own researches on this fascinating subject. He recognises four main sections with regard to the behaviour of the chromosomes in naturally parthenogenetic animals. We are sorry to see that he has not adopted Sir Ray Lankester's suggestions as to the nomenclature of parthenogenesis. In his treatment of the subject of artificial parthenogenesis Prof. Doncaster points out that there are numbers of problems which are still unsolved with reference especially to the determination of sex. The question of the restitution of a diploid chromosome number in some artificially parthenogenetic animals is also peculiar, and its mechanism ill-understood. A special chapter on the chromosomes in sex-determination has been added, somewhat on the lines of the author's "Deter-

mination of Sex." The peculiar position of Lepidoptera and Aves with regard to these matters is emphasised.

A welcome section on "Germ-cell Determinants" gives clearly the main facts which have been ascertained. The author is commendably cautious in his discussion of this interesting subject, and recognises that "although these bodies are evidently strictly correlated with the germ-cells, there is no absolute certainty that they are the cause of the differentiation of germ-cells from body-cells."

Most cytologists will concur with Prof. Doncaster in his view that the weight of evidence is in favour of the main theory of the individuality of the chromosomes; the author emphasises the fact that the chromosome itself is in all probability divisible into smaller units, which may have an individuality more fundamental than the chromosome as a whole, and he suggests that the individuality theory should be extended so as to regard these granules (microsomes) as the fundamental units.

The chapter on the mechanism of hereditary transmission introduces a discussion on the most recent work on Drosophila and Abraxas. Prof. Doncaster is here dealing with a subject which he has himself studied specially, and though he treats the question with impartiality, he comes to the conclusion that not only does the behaviour of the chromosomes in the maturation divisions of the germ-cells provide the mechanism required for Mendelian segregation of characters, but also that the work of Morgan on Drosophila carries us a step farther and gives us some idea how the groups of characters may be related to special chromosomes. The author recognises the difficulties with regard to our full acceptance of the theories of Morgan and his colleagues relating to the mechanism of "coupling" and "crossing over," but states that no other hypothesis which has been brought forward fits the main facts so well. He concludes his book with an essay on the *rôle* of the cytoplasm in heredity, and gives a good account of the organ-forming substances.

Arranged and written as it is, this book is certain to stir up interest in the subject of cytology. By pointing out the perfections and defects of our present-day basic cytological theories and hypotheses, the author has succeeded in emphasising the lines along which fruitful research may be followed. We hope that this book will mark the beginning of greater activity among English cytologists. Prof. Doncaster is to be congratulated warmly on this excellent work. J. B. G.

Matrices.

University of Calcutta: Readership Lectures: Matrices and Determinoids. By Prof. C. E. Cullis. Vol. ii. Pp. xxiii + 555. (Cambridge: At the University Press, 1918.) Price 42*s.* net.

THE history of the mathematical term "matrix" is likely to be very interesting. Its original meaning was an array of symbols (a_{mn}) forming a rectangle of m rows and n columns, out of which determinants were selected by picking out columns (or rows) of the array. A square matrix gives only one associated determinant, but a square matrix is not the same thing as a determinant.

When we change from one set of variables to another by linear relations

$$y_j = \sum_i a_{ij} x_i \quad (i = 1, 2, \ldots n;\ j = 1, 2, \ldots m),$$

we have an associated matrix (a_{mn}), or A, which is square only when the number of variables is the same in each set. In practice this is the most usual case, and it will be simpler to confine ourselves to this for the present. If we take a new set of variables z_i such that

$$z_j = \sum_i b_{ij} y_i,$$

we have a matrix $B = (b_{nn})$, and by eliminating the symbols y_i we deduce

$$z_j = \Sigma c_{ij} x_i,$$

where the symbols c_{ij} are derived from A, B by a process of "composition," and form a new matrix C. We write $C = AB$ symbolically, and thus start the theory of the multiplication of matrices. There are many analogies with the theory of groups; for instance, BA must be distinguished from AB, multiplication is associative, and so on.

Cayley seems to have been the first to develop the theory of square matrices from this point of view (Phil. Trans., vols. cxlviii., clvi., and elsewhere); other English mathematicians, such as Sylvester, Buchheim, and Tait, took up the subject later on. It may be specially noted that H. Smith's memoir on linear indeterminate equations and congruences contains a great deal of the fundamental theory of matrices, both square and rectangular. In particular, there is a complete and, we believe, original statement of the existence and properties of the elementary factors of a determinant the elements of which are ordinary integers. Weierstrass, Kronecker, and Frobenius, especially the last-named, have made important contributions to the subject.

It will be seen that a matrix is now not merely a scheme of symbols used to specify a set of deter-

minants, but a kind of entity of a very abstract and comprehensive type. A large part of group-theory and many complex linear algebras can be expressed in terms of matrices, and this absorptive property of matrix-theory will probably become more evident in course of time. Matrices occupy a special section in the International Schedule, and the Royal Society Index contains about sixty titles under that heading. Papers under other headings (especially determinants) have also more or less bearing on the subject. Prof. Baker's works on Abelian functions show the importance of matrices in the general theory of theta functions. Some knowledge of the subject is becoming essential in connection with various branches of pure mathematics.

Prof. Cullis's second volume, if we understand the author aright, seems to be a continuation rather different from that which he originally planned. This is not to be regretted, because in this portion we have statements and proofs of well-known and important theorems in the author's own notation, and a large number of illustrative examples. Among the subjects treated are ranks of matrix products and factors, equigradient transformations, certain matrix equations of the second degree, and various properties of a pair of matrices ("paratomy," "orthotomy," and so on). Much of the argument is put into a quasi-geometrical form. The outstanding feature of the work, which the author properly emphasises, is the detailed discussion of rectangular, as distinguished from square, matrices. For this reason alone the work ought to give a great stimulus to the subject, and we hope that the publication of the whole treatise will not be long delayed. Until it is finished, it will be difficult, if not impossible, to give a proper appreciation of it, especially as the author introduces so many new symbols and technical terms. One thing, however, is certain: we now have the outlines of a calculus of matrices in which the operations of addition, subtraction, and multiplication are definite. It may be conjectured that some of the most important applications will be to problems connected with a compound modulus, arithmetical or algebraical as the case may be.

As a matter of curiosity it may be noted that one or two of the very first problems in the theory of rectangular matrices occur in Gauss's "Disquisitiones Arithmeticæ"; for instance, in connection with the theory of composition of quadratic forms, we have the problem of finding a matrix $(a_{2,4})$ the six determinants of which are to be six assigned integers, subject to a certain relation.

G. B. M.

The Chemistry of Animal Products.

The Essentials of Chemical Physiology: For the Use of Students. By Prof. W. D. Halliburton. Tenth edition. Pp. xi+324. (London: Longmans, Green, and Co., 1919.) Price 7*s.* 6*d.* net.

THE fact that this well-known and appreciated text-book has reached its tenth edition is sufficient evidence that it satisfies adequately the need for a short practical course in the chemistry of the substances found in and produced by the activity of living tissues. This object is excellently attained. It is not to be expected that a detailed account of the chemical processes occurring during the life and functional action of the organs of the body is to be found therein. Indeed, it would be impossible to separate the chemical from the physical aspects of any of these physiological processes. Such a separation appears to be an unfortunate necessity in a great part of the teaching of the subject, but a more intimate union between the chemical side and what is sometimes called the "experimental" side of the student's work is very desirable, and might be arranged without much difficulty.

There are some important questions which are apt to fall out in the present arrangement; such are those of permeability, osmotic pressure, hydrogen-ion concentration, and the properties of colloidal solutions. In a future edition Prof. Halliburton might find it possible to include a few simple exercises in these problems. An intelligent grasp of the principles involved is not to be attained by the mere reading of statements about them, while even a small number of experiments have great value. On account of its importance in physiological phenomena, some experiment showing the synthetic aspect of the action of enzymes might well be inserted.

A general criticism which applies to most text-books on practical chemistry, especially to those on biological chemistry, is that a number of the tests given suggest cookery recipes rather than scientific experiments. A student is very little the better for performing Molisch's sugar test if he is ignorant of what the result is due to. And how many understand, when they make the tests, why some sugars reduce copper salts, while others do not; or why tartrates are added to Fehling's solution? It would often be better to curtail the recital of what is to be found in general text-books in order to explain the reasons for the results of the actual experiments made.

In the book before us the theoretical part is, on the whole, brought well up to date. In view of

recent work, however, the statements with respect to anti-enzymes might well have been more critical. Some of us might demur to the statement on p. 83 that margarine-makers have learned to make this fat palatable. W. M. B.

Physics: Theoretical and Practical.

(1) *A Handbook of Physics Measurements.* By Ervin S. Ferry, in collaboration with O. W. Silvey, G. W. Sherman, jun., and D. C. Duncan. Vol. i. *Fundamental Measurements, Properties of Matter and Optics.* Pp. ix+251. Vol. ii. *Vibratory Motion, Sound, Heat, Electricity and Magnetism.* Pp. x+233. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918). Price 9*s.* 6*d.* net each vol.

(2) *Notes on Magnetism: For the Use of Students of Electrical Engineering.* By C. G. Lamb. Pp. viii+94. (Cambridge: At the University Press, 1919.) Price 5*s.* net.

(1) IN the two volumes forming "A Handbook of Physics Measurements" are given the theory and manipulation of those experiments which experience has shown to be most important in pure and applied science. The work is designed for college and industrial laboratories, and forms a self-contained manual. Each chapter consists of two parts; the first includes definitions, a description of the apparatus, and the general theory of the methods, while in the second each determination is described in detail, the more important sources of error are pointed out, and means are indicated by which these errors may be minimised or accounted for. Most of the experiments require no mathematics beyond trigonometry and algebra, but the authors have rightly decided to employ the calculus methods wherever these would result in economy of time and mental effort.

No student except one specialising in physics would perform all 108 experiments included in the two volumes. Other students, after performing the necessary experiments on the properties of matter, would limit themselves to the groups bearing directly upon their principal study. Thus the chemist would do the work on indices of refraction, using various forms of refractometer, such as the Pulfrich, the Zeiss, the Abbe, the Féry, or the more recent instrument designed by Dawes. He would also make use of spectroscopes and spectrophotometers, and learn that "spectrocolorimetry"—the estimation of the concentration of solutions by means of the intensity of the absorption bands of their spectra—is a method which may be both more speedy and more precise than chemical analysis. The electrical engineer would do the work on damped vibration and harmonic analysis, in addition to the usual experiments on the determination of resistances, capacities, or inductances. The mechanical engineer will be interested in the methods for the determination of the economy effected by steam-pipe coverings and of the thermal value of both coal and gas. The work as a whole is to be recommended as giving a thoroughly up-to-date account of most of the important physical instruments and experimental methods.

(2) For the use of students in the engineering laboratory, Cambridge, Mr. Lamb has drawn up a convenient set of notes dealing with the essential parts of the subject of magnetism. Starting with fundamental facts and principles, such portions of magnetic theory are outlined as are required in order to read the ordinary technical text-books with intelligence. The work has been well done, and the latter part of the book, dealing with magnetic hysteresis and alternating-current tests, will be of special service to both students and teachers, who will welcome the admirable diagrams and the lucid descriptions. H. S. A.

Minerals and Metals.

(1) *Zinc and its Alloys.* By Dr. T. E. Lones. (Pitman's Common Commodities and Industries. Pp. ix+127. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 2*s.* 6*d.* net.

(2) *Asbestos and the Asbestos Industry: The World's Most Wonderful Mineral and other Fireproof Materials.* By A. Leonard Summers. (Pitman's Common Commodities and Industries.) Pp. ix+107. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 2*s.* 6*d.* net.

(3) *Tin Ores.* By G. M. Davies. Pp. x+111.

(4) *Manganese Ores.* By A. H. Curtis. Pp. x+118. (Imperial Institute: Monographs on Mineral Resources, with Special Reference to the British Empire.) (London: John Murray, 1919.) Price 3*s.* 6*d.* net each.

THE first two of these little books are two of the volumes in a series issued with the object of giving general readers an account, in language as untechnical as possible, of the origin, mode of production, and uses of a number of the essential articles employed in industries. The object is an excellent one, for it is knowledge of a kind that the user and even the merchant of these materials rarely possess, though the advan-

tage of having such information is sufficiently obvious.

(1) The volume on zinc is an excellent example of what such books ought to be; it gives, first, a brief history of the metal, then a description of the various ores from which it is extracted, and of the processes employed in dressing these ores or rendering them marketable, including, it may be noted, a very fair summary of the modern flotation processes. The next chapters give a good and quite up-to-date account of the methods employed in smelting the metal or extracting it from the ores, and a final chapter is devoted to the alloys of which it forms an important constituent. It is a pity that the author did not keep clear altogether of chemical equations, which he might easily have done in a purely popular treatise, as he has been somewhat unfortunate in their use; it is difficult to understand how he ever came to write such an equation as

$$2ZnS + 2O_2 = Zn_2 + 2SO_2,$$

for the context shows that he knows well enough that no such reaction ever takes place. Again, he would have done better to omit the equation $2ZnO + 2CO = Zn_2 + 2CO_2$, because although oxide of zinc can be reduced by carbonic oxide, the reaction can take place normally only in the presence of excess of carbon, which at once again reduces the carbonic anhydride to carbonic oxide. The author's equation would suggest that carbonic anhydride is evolved in the process of zinc smelting, whereas, in fact, the evolved gases consist almost entirely of carbonic oxide. In a future edition the author might with advantage devote a little space to the galvanising of iron, seeing that about half the world's production of zinc is used for this process.

(2) The volume on "Asbestos" decidedly suffers by comparison with its companion volume, as the author does not take care to avoid a number of errors, which, though common enough in the trade, ought not to find their way into a book of this description. He does not by any means make it clear, as he should have done at the outset, that the trade name "asbestos" is applied to several different minerals; the name was apparently given originally to tremolite, actinolite, and other varieties of amphibole, but it is also applied to fibrous forms of pyroxene, to the very different mineral crocidolite, distinguished by the large proportion of ferrous iron that it contains, and, lastly, to chrysolite, a fibrous variety of serpentine, which differs from all the foregoing in that it is a hydrated silicate, whereas all the others are anhydrous. Again, no serious work should contain such statements as: "Next to coal, asbestos is now undoubtedly the most important of the non-metallic mineral products of the world," or "older than anything in the animal or vegetable kingdom"; surely the author cannot suppose that asbestos is of more importance than salt, for example, and surely he would not question the inclusion of, say, Silurian trilobites in the animal kingdom. His statement that the works of the United Asbestos Co., Ltd., at Harefield, Middlesex, are alongside a coal-pit is unintelligible; there are certainly no collieries in that part of England. When he deals with the manufacture of asbestos into cloth, yarn, packing, boiler coverings, and the numerous patented materials of which it forms an essential constituent, he is on safer ground, and supplies much useful information in a convenient form.

(3) and (4) The Imperial Institute is doing excellent service in issuing the handy monographs on the mineral resources of the British Empire, two of which have recently appeared. There is, of course, nothing new in either of these works, they being careful compilations of well-known information and statistics; this does not imply that the production of such compilations is at all an easy task, or that the compiler has not done good service in carrying it out. On the contrary, the collection of the large mass of material which has here been brought together requires a laborious and painstaking search through many and various sources of information, not all of which are readily accessible to the general reader, as a glance at the very useful bibliographies appended to both volumes will at once show. In one respect the two mineral substances discussed in the respective volumes show a marked contrast: workable tin ores occur in relatively few localities, whilst ores of manganese are very widely distributed, and to be found in most parts of the world, although it is true that large deposits of manganese ores are far from plentiful; but in other respects the tasks of the authors have been very similar.

The general scheme of both books is identical. The first chapter is devoted to the uses and applications of the metal and its compounds, and to the nature and general characters of the ores; the second deals in some detail with the occurrences of the ores within the British Empire; and the third reviews briefly the main sources of supply in other parts of the world. In both cases the work has been carefully and thoroughly done, and the handbooks may be looked upon as giving trustworthy information upon the subjects treated in a compact and convenient form.

Our Bookshelf.

The Engines of the Human Body: Being the Substance of Christmas Lectures Given at the Royal Institution of Great Britain, Christmas, 1916–1917. By Prof. Arthur Keith. Pp. xii+284+ii plates. (London: Williams and Norgate, 1919.) Price 12*s.* 6*d.* net.

WORKS on physiology commonly appeal either to the usual types of student, or else to those engaged in teaching or research work. The work before us claims to appeal in the first place to the general reader "who desires to know what modern medical teachers think of the marvellous contrivances of the human machine." The title of the book, with the foregoing quotation, indicates the spirit in which the author has approached the subject. Prof. Keith's fertile imagination has sought analogies between the various functions of the organs on one hand, and divers mechanisms of human design on the other, and he certainly never seems at a loss for them. In so far as the general reader has no previous knowledge of the subject, the method of treatment by analogy alone seems calculated to give rise to an abundant harvest of grotesque misconceptions, as all those who have taught elementary physiology are well aware; but the book should be truly welcome to a teacher who, while having some acquaintance with the subject, is yet lacking in the knowledge or imagination necessary to evolve instructive analogies to help to fasten in the pupil's mind what he wishes to impart.

Many of the mechanical analogies are quite new and should be worth adopting, but others seem superfluous or misleading; for example, the comparison of muscular tissue with an internal-combustion engine is a sound and generally recognised conception, up to a certain point; but to refer to tendons as "piston cords," or to arteries and veins as supply and exhaust pipes, is pushing a good analogy to the point of whimsicality. For the first thirteen chapters, however, in spite of this, the reader should go along smoothly enough, but after this point, when analogies fall thick as autumn leaves, the general reader is likely to lose sight of the track. There are some inexactitudes in the book which do not fall in the category of bad analogies; for example, the statement that the velocity of the nerve impulse is four miles a second, that nerves are "living and pulsating," and that nerves are subject to fatigue (p. 263). The historical fragments which are frequently introduced are of considerable merit, partly on account of the relief experienced by the reader in meeting plain, unveiled fact, but chiefly because they are exceedingly well chosen.

C. L. E.

A Class-book of Organic Chemistry. By Prof. J. B. Cohen. Vol. ii.: For Second-Year Medical Students and Others. Pp. vii+156. (London: Macmillan and Co., Ltd., 1919.) Price 4*s.* 6*d.*

THE average medical student is inclined to regard chemistry as a subject which has to be studied in order to pass certain examinations, and having passed these, he dismisses the subject from his mind. This is in large measure due to the fact that the text-book he has come across has failed to stimulate his interest, and the probability is that he will get rid of the book at the earliest opportunity.

The little volume under review, however, is one that we venture to think the student will not be likely to part with, as it gives a very clear, concise, and readable account of the subject, which may stand him in good stead in his future studies; it is divided into ten chapters, as follows: Synthesis, The Oils and Fats, The Carbohydrates, Some Natural Organic Bases, The Pyrimidine and Purine Groups, The Proteins, Fermentation and Enzyme Action, The Essential Oils, The Alkaloids, and Synthetic Drugs. Each of the sections is thoroughly up-to-date, and we know of no book which, within so small a compass, deals with such varied subjects as, for example, the Grignard reaction, the synthesis of disaccharides, the origin of uric acid in the animal organism, and the theory of alcoholic fermentation, besides giving the constitutional formulæ, so far as they are known, of yeast-nucleic acid, hæmin, ætiophyllin, and the more important alkaloids, such as strychnine and morphine. The last chapter, in addition to giving the constitution of many of the better-known synthetic drugs, contains a short account of the more recent antiseptics, such as chloramine-T, and the dyestuffs malachite green, acriflavine, etc., as well as a brief sketch of the trypanocidal action of the organic arsenic compounds.

The first volume, published in 1917, was meant to serve as an introduction to organic chemistry, and the two volumes together can be thoroughly recommended as a most excellent and handy little compendium, which should find great favour among students and teachers alike.

Examples in Electrical Engineering. By J. F. Gill and F. J. Teago. Pp. 173. (London: Edward Arnold, 1920.) Price 7*s.* 6*d.* net.

A BOOK of this kind, which consists of a collection of model examination papers, followed by model replies, should be not without its uses to those who are obliged to study the art of passing examinations, as well as the principles of electrical engineering, as a careful perusal of its contents will enable the student not only to practise his knowledge of the various parts of the subject, but also to form good habits in the way of presentation of the solution of the problems in a clean form and logical sequence. The drawing of good diagrams and the frequent use of graphical methods are very rightly insisted on, and admirable conciseness is observed. The papers cover both "intermediate" and "advanced" standards, and relate on the whole to practical applications rather than to theory.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Plumage Bill and Bird Protection.

AT the present time there is a measure before the House of Commons known as the Importation of Plumage (Prohibition) Bill, the object of which is "to prohibit the importation of the plumage of birds and the sale or possession of plumage illegally imported," excepting the plumage of ostriches and eider ducks, but "the prohibition or importation imposed by the Act shall not apply to any plumage imported in the baggage or as part of the wearing apparel of a passenger." The Bill further provides for the granting of a licence, subject to certain conditions and regulations, authorising the importation of plumage for natural history museums, for the purpose of scientific research, or for any other special purpose.

In connection with this measure numerous conflicting interests are threatened and grave misunderstandings exist, due very largely to lack of knowledge of the actual facts. Whilst yielding to no one in my love of wild birds and all the æsthetic interests associated with wild-bird life, I cannot shut my eyes to the fact that a considerable amount of sentimentalism, misrepresentation, and exaggeration has been put forth by supporters or well-wishers of this measure, and similarly by the opposers respecting trade losses, the extent of the employment the trade ensures, the absence of cruelty involved in the trade, etc. Neither of these views helps us to understand the situation or calmly and dispassionately to form an unbiassed opinion, for both of them are far from the actual truth.

There is now ample evidence to show that a considerable trade is done in the plumage and skins of wild birds which are largely utilised for the decoration of women's hats, etc. In different centres, such as London, Manchester, Paris, Berlin, Vienna, and elsewhere, this trade affords employment to a number of workers. The "horrors and barbarities of the traffic" have been luridly described by one set of writers and denied by another. Without accepting either of these sets of exaggerated statements, information in my possession shows that gross cruelty is frequently committed. Prof. E. H. Forbush states that brutal savagery is characteristic of this phase of bird destruction, and points out that this "has been well illustrated in the extermination of the egrets of the United States." No unprejudiced mind can exonerate or satisfactorily explain away this highly objectionable side of the question.

Of the species of birds sought after, we are constantly being assured that they are injurious, that they are "as common as rooks," or that we do not possess any exact information as to the effect this trade has had upon their numbers. The fact is that the majority of the species are beneficial so far as agriculture or horticulture is concerned, and only a very few injurious. There is exact and incontrovertible evidence that where thirty-five or forty years ago millions of birds existed, they are now practically extirpated. A single "rookery" of egrets was estimated by a well-known ornithologist to contain three million birds in 1878; in 1888 they were rare, and in 1908 almost extinct.

It is pointed out by supporters of this Bill that prohibition laws exist in America, Australia, India, and elsewhere, but it is not mentioned that, in the opinion of many competent judges, in consequence of such laws certain beneficial species of birds have suffered and injurious ones unduly increased.

Again, it has been suggested that such birds as egrets might be cultivated in natural reserves, and their plumes or "aigrettes" collected as the birds moult. The most perfect of such feathers, so we are informed, fetch as much as 2*l.* apiece. That the farming of these birds is a practicable scheme is proved by the fact that the National Association of Audubon Societies in the United States has established such a colony on a small island in the Stono River, near Charleston, and in 1917 it was tenanted by more than four hundred birds. Again, on Avery Island, Louisiana, U.S.A., there is a "rookery" of snowy egrets which in 1916 was carefully examined by Prof. J. S. Huxley, and reported to contain between eight and nine hundred nests. It may be well, perhaps, to remind the advocates of such schemes that, like all members of the family Ardeidæ, herons and egrets subsist very largely upon fish, and there is little doubt that the establishment of a series of large rookeries would have a disastrous effect upon fresh-water fisheries.

Whilst in no manner advocating opposition to this Bill, we must face the question: Supposing that it is placed upon the Statute-book, shall we have done anything to stop the trade in the skins and plumage of wild birds? Personally, I have grave doubts whether the object desired can be obtained by this measure. As an Act of Parliament its example and influence may be for good, but it will certainly not put a stop to the plumage trade. It must be realised that if we prohibit this trade in London, it will still flourish in Paris, Berlin, and elsewhere. The Bill will simply move the venue of the market; it will not bring about a smaller demand. To put an end to this we must educate the public, not by giving currency to wild and often inaccurate statements, but by teaching the rising generation "to view the question of the preservation of wild-bird life from a higher and much truer standpoint than heretofore. That wild birds have a utilitarian value no one can deny, but they also have an æsthetic value far outweighing all others. . . . Surely the general public have some rights where beautiful natural objects are concerned. . . . Posterity will undoubtedly regard us—and who shall say not rightly?—as stupid people, dull of apprehension and procrastinating in nature, in that we have permitted various species of wild birds, one after another, to disappear from our land; and our children's children will rise up and ask why we did not secure to them the natural pleasures which their forefathers could have enjoyed had they had eyes to see with and minds tuned beyond the din and bustle of the highways and byways of commerce" (*National Review*, 1920, p. 95).

Whilst the decoration of the person with wings and feathers may be regarded as the vulgar and depraved fancy of a day, the fact cannot escape us that there is a large section of the general public who are willing to pay high prices for these goods; and so long as this demand continues, so long will a supply be forthcoming.

By making the Plumage Bill a law of the land we can say that in this country we will have nothing to do with the trade and that it shall be prohibitory to carry on the trade in the United Kingdom. That it will have any effect on the destruction of wild-bird life, however, is certainly most unlikely. A plentiful supply

of the goods will be forthcoming so long as a demand exists, but once it is regarded as offensive—or shall we say indicative of a lack of good taste?—to wear such things as the wings, heads, feathers, or bodies of birds, the demand will cease and the trade, so far as this country is concerned, disappear. Herein, we think, lies a remedy far more effective than any Act of Parliament. WALTER E. COLLINGE.

The University, St. Andrews, March 27.

The Physiology of Migrations in the Sea.

THE flat-fishes of Northumberland in the immature condition migrate more or less inshore in summer and offshore in winter. Flounders are relatively static, plaice migrate offshore to the north-east and dabs to the south-east. The migration is not, as a rule, conspicuous, and, so far as the young stages are concerned, might be regarded as not taking place.

With approaching maturity, however, these three species migrate far to the north. The flounders for the most part reach the coast of Fife, and the plaice deeper water off the Forth and the Scottish coast to the north. The dabs do not appear to migrate so far to the north as the plaice, but we have a record of one that migrated so far as St. Andrews Bay. Fulton has shown that the Moray Firth plaice migrate to the north, and even to the Atlantic.

The migrations may be said, therefore, to be a series of seasonal inshore and offshore movements, followed by a marked contranatant journey for spawning. After spawning the spent fish resume the seasonal migrations, and become then, more obviously, summer inshore migrants.

We have thus plainly two factors at work: one external, which may be associated with temperature, the other internal, which we at once conclude to be due to the action of an internal secretion. The seasonal migrations are obviously independent of the spawning migration, and may be said to be produced by hydrographical conditions and the contranatant ability of the fish. Under the influence of the spawning impulse fish migrate usually to a great, and sometimes to an immense, distance. The effect is strong enough to force the eel to descend from fresh water to the sea, and thence to mid-ocean, and to impel the salmon from the sea to the river, and, in spite of difficulties, to the spawning-ground.

The spawning migration is not always so plainly marked, but these considerations go to show that all fish migrations are of a similar character, a general seasonal series of movements affecting all, and a special migration under the dominating influence of an internal secretion or hormone, which, proceeding from the developing gonad, is carried by the blood to the nervous system. With reference to the species referred to above, it can be said that the hormone begins to exert its influence about autumn or the later months of the year, and continues its effect during the whole period of ripening. It is periodic in its manifestations, and the call, when it comes, is imperative. Only in special circumstances, as lack of water, say, in the river, can the spawning migration be said to be modified by hydrographical or other physical conditions. The distinction between the two kinds of migration must be clearly kept in view if we are to understand and appreciate the results of marking experiments. From, say, November to the spawning season mature plaice are contranatant migrants; after spawning they are denatant, or usually so, until the winter. The large number of records which have been accumulated, resulting from the investigations of past years, should be reconsidered with this in mind.

It is interesting to observe that the only invertebrate of the migration of which we have direct proof behaves almost exactly like the plaice and the flounder. The common edible crab (*Cancer pagurus*) migrates inshore in summer and offshore in winter with the greatest regularity. Maturity impels the female to become a contranatant migrant. The females migrate from the Northumberland coast to the southern coast of the Firth of Forth, some of them still further to the north, even to the Moray Firth, the general results indicating a direct relationship between size and distance. The hormone is therefore secreted in the crab by the developing ovary, and it reacts in exactly the same way as that of the fish. The experiments have clearly proved that the migration does not occur until the winter before the season of spawning, and in this respect the crustacean and the fish are in agreement. It takes place during the offshore winter migration and in deep water, but the effect is differential, the male not migrating. It is not necessary for the male to migrate, as the migration takes place after pairing, even a year or two years after. This appears to indicate that the internal secretion is under control or may be withheld in response to evolutionary necessity.

Dr. Gurley, in the *American Journal of Psychology* (1902 and 1909), brought under review the indications of the intoxication of the central nervous system by internal secretions as explaining the spawning migrations of fresh-water fish in North America; so that the point is not new. We do not know very much about the internal secretions, but we know enough to be able to say that they act directly and quickly as an intercommunication between organs with or without reference to the nervous system. In the sea the effects are indicated by migration in the case of such animals as are capable of making migrations, but it is obvious that in many cases the internal secretions derived from the gonad have somatogenetic as well as mental effects, as in the development of secondary sexual characters.

The developing gonads of fish and the crab offer interesting material for the investigation of internal secretions by a biochemist. My main object, however, is to indicate that we already know the general facts and laws of migration, that marking must be done intelligently and the results read with due consideration of the laws, and more especially that the spawning migration is due to an intoxication of the central nervous system, and brings about a migratory result independent of temperature, salinity, and every other hydrographical condition.

ALEXANDER MEEK.

Armstrong College, Newcastle-upon-Tyne,
March 30.

Muscular Efficiency.

WHEN muscular force is exerted, power is expended and fatigue is produced, even when the muscle remains stationary. Again, when no external force opposes the contraction of the muscle, physiological causes set a limit to the speed at which contraction can take place. In both cases the whole power expended is lost in so far as the production of useful work is concerned. When there is no velocity the power is used in maintaining the stress, and when there is no resistance, in maintaining a constant velocity.[1]

In all ordinary muscular operations both these sources of power leakage act simultaneously but in

[1] This loss is independent of any power lost in the acceleration of the parts.

different degrees, and it becomes a definite problem to determine for any muscle or combination of muscles the relation between the speed of muscular contraction and the muscular force which will yield the greatest external power. The problem may be solved by means of the diagram in Fig. 1.

It is assumed that the muscular machine has a constant output of power which is represented by the product xy (x pressure, y velocity) of the co-ordinates of the hyperbola AB. Also, that the pressure available for producing exterior power is less than x by some quantity $\psi(y)$ depending on the velocity, and represented in the figure by the abscissa of the curve DD′, the effective velocity in the same way being less

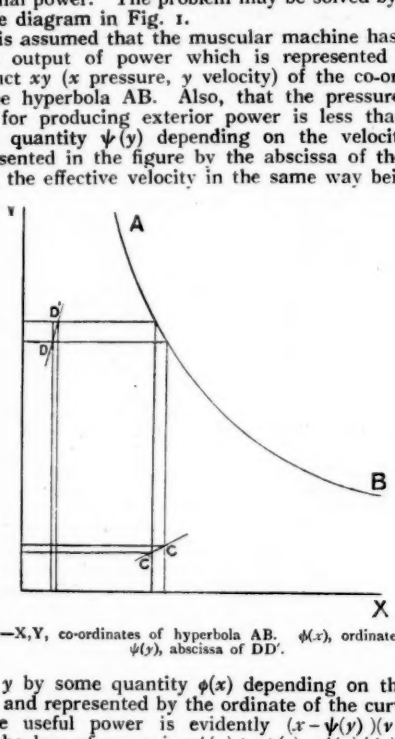

FIG. 1.—X,Y, co-ordinates of hyperbola AB. $\phi(x)$, ordinates of CC′. $\psi(y)$, abscissa of DD′.

than y by some quantity $\phi(x)$ depending on the pressure, and represented by the ordinate of the curve CC′.

The useful power is evidently $(x-\psi(y))(v-\phi(x))$, and the loss of power is $x\phi(x)+y\psi(v)-\phi(x)\psi(y)$.

If the co-ordinates for $x+dx$ and $y+dy$ are drawn as in the figure, it is plain that the loss is a minimum (and the useful power, therefore, a maximum) when $(x-\psi(v))d\phi(x)+(v-\phi(x))d\psi(y)=\psi(y)\,dy+\phi(x)dx$.

I know of no experiments which would determine the form of the functions ϕ and ψ—that is, what power is lost in sustaining a load or in keeping a uniform speed. Both these subjects are worthy of investigation, and, with the facilities offered by some

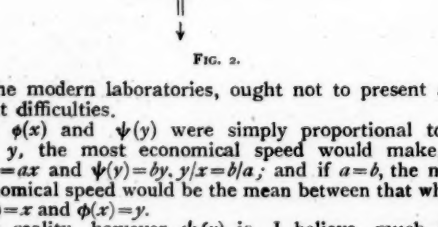

FIG. 2.

of the modern laboratories, ought not to present any great difficulties.

If $\phi(x)$ and $\psi(y)$ were simply proportional to x and y, the most economical speed would make, if $\phi(x)=ax$ and $\psi(y)=by$, $y/x=b/a$; and if $a=b$, the most economical speed would be the mean between that where $\psi(y)=x$ and $\phi(x)=y$.

In reality, however, $\psi(y)$ is, I believe, much less than $\phi(x)$, but this remains for experimental determination. It may be noticed that as $\psi(v)/\phi(x)$ decreases, the most economical speed increases.

A close analogy to the conditions of the problem may be found in a fluid contained between two pistons A and B (Fig. 2), between which there is a leak governed by the fluid pressure. A constant power urges A towards B, and A itself is subject to a frictional resistance depending on its speed. The useful work is represented by the velocity of B against an exterior force, while the leak stands for $\phi(x)$ and the frictional resistance of A for $\psi(y)$.

A. MALLOCK.

A Dynamical Specification of the Motion of Mercury.

IF we assume that the modified Lagrangean function for two mobile and massive particles is of the form

$$L=\tfrac{1}{2}m_1(\dot{x}_1^2+\dot{y}_1^2+\dot{z}_1^2)+\tfrac{1}{2}m_2(\dot{x}_2^2+\dot{y}_2^2+\dot{z}_2^2)$$
$$+\frac{\gamma m_1 m_2}{r}\left[1+\frac{\lambda}{C^2}\{(\dot{x}_1-\dot{x}_2)^2+(\dot{y}_1-\dot{y}_2)^2+(\dot{z}_1-\dot{z}_2)^2\}\right]$$

where the symbols have the usual meaning, C being the velocity of light and λ a pure number, then the principle of least action $\delta\int L\,dt=0$ leads to the following conclusions:

(1) The motion of the centre of mass is constant.

(2) The orbits of the two particles about their centre of mass are similar and similarly described plane curves, and independent of the motion of the centre of mass.

(3) For the orbital motion the modified Lagrangean function is:

$$L^1=\tfrac{1}{2}\frac{m_1m_2}{m_1+m_2}\left\{1+\frac{2(m_1+m_2)\lambda\gamma}{rC^2}\right\}(\dot{r}^2+r^2\dot{\theta}^2)+\frac{\gamma m_1 m_2}{r}$$

Hence the equations:

$$\left\{1+\frac{2(m_1+m_2)\lambda\gamma}{rC^2}\right\}(\dot{r}^2+r^2\dot{\theta}^2)-\frac{2\gamma(m_1+m_2)}{r}=\text{const.}$$
$$=-\frac{\gamma(m_1+m_2)}{a}$$

and
$$\left\{1+\frac{2(m_1+m_2)\lambda\gamma}{rC^2}\right\}r^2\dot{\theta}=\text{const.}=h$$

Writing $r=1/u$, we have:

$$\left(\frac{du}{d\theta}\right)^2+u^2=\frac{2\gamma(m_1+m_2)}{h^2}\left(u-\frac{1}{2a}\right)\left\{1+\frac{2(m_1+m_2)\lambda\gamma u}{C^2}\right\}$$

From this we may deduce

$$\frac{d^2u}{d\theta^2}+u\left\{1-\frac{4\lambda}{C^2}\frac{\gamma^2(m_1+m_2)^2}{h^2}\right\}=\frac{\gamma(m_1+m_2)}{h^2}\left\{1-\frac{\lambda\gamma(m_1+m_2)}{C^2a}\right\}$$

or the solution in the form

$$u=\frac{1}{l}\left\{1+e\cos(\mu\theta+\eta)\right\}$$

where
$$\mu^2=1-\frac{4\lambda\gamma^2(m_1+m_2)^2}{C^2h^2}$$

These equations are exact.

In applying this argument to the observed apsidal progress of the planet Mercury, it is to be noted that the interpretation of a and h differs slightly from what it would be if λ were zero; but to a sufficient degree of

approximation we find that the apsidal progress per revolution is

$$\frac{4\pi\lambda\gamma^2(m_1+m_2)^2}{C^2h^2}$$

The observed value requires that λ should be nearly 3/2, and if 3/2 is taken, we get the result obtained by Prof. Einstein by his new specification and principles.

It may be observed that the above specification by the Lagrangean function could be generalised for any number of particles, and that it involves no departure from recognised dynamics or the normal views of space and time. It does, however, involve the conclusion that the interaction of bodies through the æther, vaguely called "gravitation," is to a very slight degree not exactly in accordance with Newton's specification. Whether such conclusion is really necessary seems still a matter of doubt.

I have not seen any discussion of the problem of two bodies on Prof. Einstein's specification, but it appears to me that an exact determination of the relative orbit when m_1 and m_2 are comparable quantities is very desirable. GEORGE W. WALKER.

Portsmouth, March 29.

The Construction of a Magnetic Shell Equivalent to a Given Electric Current.

ACCORDING to Ampère's theorem, the magnetic field due to an electric current flowing in any circuit is equivalent at external points to that due to a simple magnetic shell the bounding edge of which coincides with the conductor, and the strength of which is equal to the strength of the current.

It is generally understood that any surface having the circuit as its boundary will serve as the surface of an equivalent magnetic shell, and the fact that there is a restriction on the nature of the surface does not appear generally to be recognised.

Thus, for example, in Maxwell's treatise (vol. ii., p. 142) we find the following:—"Conceive any surface S bounded by the circuit and not passing through the point P"; while further on he says: "It is manifest that the action of the circuit is independent of the form of the surface S, which was drawn in a perfectly arbitrary manner so as to fill it up."

I propose to show by means of a simple example that the surface is not drawn in a "perfectly arbitrary" manner.

Consider a narrow, rectangular strip of paper the opposite edges of which we shall denote by *a* and *b*, its opposite faces by A and B, and its two ends by 1 and 2. We shall represent the ends of the edges by a_1, b_1, a_2, b_2, where the suffixes refer to the corresponding ends of the strip. Now let one end of the paper be turned round through an angle π and joined on to the other end, so that a_1 is joined to b_2 and b_1 to a_2.

Then, since a_1 is joined to b_2, the edges *a* and *b* form one continuous line, and, since b_1 is joined to a_2, this line forms a closed circuit.

Thus we may bend a wire into the form of the edge, and can imagine an electric current to flow in it.

Although the electric circuit has the form of the edge, yet we could not have a simple magnetic shell the surface of which was that of the paper.

This is easily seen, for since, in addition to the edges, the faces A and B have also become continuous one with the other, we can no longer distinguish one as positive and the other as negative. The same thing is seen if we try to imagine the surface divided up into elementary portions, in the manner conceived of by Ampère, with a current equal in strength to the given current flowing round the boundary of each.

It is easily seen that Ampère's construction fails for such a surface, which is known to mathematicians as a Möbius sheet.

Although the surface we have described would not serve as the surface of a simple magnetic shell equivalent to an electric current flowing round its boundary, yet it is possible to construct other surfaces having this boundary which would serve as surfaces of equivalent magnetic shells.

If we have one suitable surface we can obtain any number of others from it by continuous deformation while the edge remains fixed.

It is, therefore, desirable to give a general method of constructing a magnetic shell equivalent to a given electric circuit. The following appears to give a surface having the required property:—

Let O be a fixed point external to the circuit, and let P be a variable point. Let P travel once completely round the circuit, so that the radius vector OP traces out some conical surface.

The portion of this conical surface containing O and bounded by the circuit might then be taken as the surface of the equivalent magnetic shell.

In the particular case of the circuit we have considered (as well as in many others) the surface will cut itself, but will, nevertheless, have two distinct faces, one of which may be taken as positive and the other as negative. It thus appears to satisfy the necessary conditions. A. A. ROBB.

March 30.

Volcanic Rocks in the Anglo-Egyptian Sudan.

IN connection with Prof. J. W. Gregory's reference in NATURE of February 19, p. 667, to the discovery of the Bayuda volcanic field, and Mr. Campbell Smith's record of a riebeckite-rhyolite which constituted a number of stone implements found at Jebel Katul, in Northern Kordofan (*ibid.*, February 26, p. 693), some further notes may be of interest.

The rock collected by Sir Herbert Jackson at Merowe is a basaltic scoria, and the specimens either float or just sink in water. A few crystals of olivine are visible to the eye, and, under the microscope, a regular basaltic ground-mass, including felspar, iron ores, and probably glass, can be recognised in the powdered rock. The specimens have evidently been transported by a stream system which drains from the south-east and debouches on the river at the spot where they were found. Save for the neighbourhoods of the river and a few routes by which travellers avoid the long journey around the Abu Hamed bend of the Nile, the maps of the Bayuda Desert are almost blank. Near one of the routes a surveyor has recorded "Hosh Eddalam, crater," and the name means a dark enclosure. Some of the older travellers mistook ironstone concretions for volcanic bombs, and as the surfaces of many rocks are darkened in the desert such a record of a crater did not call for particular note until evidence of extrusive rocks appeared. It is situated in latitude 18° 20′ N., longitude 32° 31′ E., and consequently lies to the west of the route taken by Dr. Chalmers Mitchell. The volcanic field seen from the air probably does not lie on the established routes, as it would certainly have been referred to in reports, even if it were not described. Presumably there can be no doubt about the existence of craters seen by an observer such as Dr. Chalmers Mitchell, but the results of an examination on the ground will be of interest, even if only to know the types of rocks involved.

Mr. Stanley C. Dunn records the presence of rhyolites and felsites near Jakdul, and these are doubtless

similar to those of the Sixth Cataract, about forty miles north of Khartum, where the volcanic rocks are certainly older than the Nubian Sandstone. In the northern parts of Dongola basalt intrusions occur in the Nubian Sandstone, and there is a hot spring at Akasha, about eighty miles south-west of Halfa. Turning to more distant regions, one of the solitary landmarks on the White Nile is Jebel Ahmed Aga, in latitude 11° N., consisting of the remains of a volcanic cone formed of basaltic scoria and evidently of comparatively recent age. Towards the east there are the plateau basalts of Abyssinia, with outliers extending into the Sudan. Along the Langeb Valley, north of Kassala, there is an interesting suite of acid and intermediate volcanic rocks, but we are still in doubt about their age. Similar rhyolites certainly occur farther north among the Red Sea hills. The western parts of Kordofan have been traversed geologically without revealing the existence of volcanic rocks on the continuation of the line referred to by Mr. Campbell Smith. Farther west Darfur appears to be full of recent volcanic rocks, principally of scoriaceous types.

The N.E.–S.W. features seen by Dr. Chalmers Mitchell may have been to some extent due to erosion by sand driven from the N.N.E. by the prevalent wind. The direction of strike among the metamorphic rocks is another factor to be borne in mind. It is not constant over these large areas, but it is very often N.E.–S.W., and would then account for some of the features seen from the air. In these circumstances caution appears desirable in basing wide structural theories on rather scanty data.

G. W. GRABHAM.

Box 178, Khartum, March 25.

The FitzGerald-Lorentz Contraction Theory.

IN the discussion on relativity at the Royal Society on February 5 (NATURE, February 12), Mr. Jeans stated that the FitzGerald-Lorentz contraction theory presented grave difficulties in the case of a wheel rotating about a fixed axle, so that the circumference would contract while the radius would not. Surely these difficulties are not so grave as would appear at first sight? Let us adopt the point of view of the old-fashioned non-relativist to whom space is rigid and Euclidean, even though his measuring instruments may change and so introduce errors in his measurements. A scale is not a rigid invariable unit of length. Its length, even if its orientation is unchanged, depends on its temperature and the tensile or compression stresses to which it is subjected. If we change its temperature, keeping the stresses constant, its length (as measured by a standard scale at fixed temperature) varies. But we may by suitable means prevent the variation of length, in which case the change of temperature will cause a change of stress. Similarly, on the FitzGerald-Lorentz theory, turning the scale to a different orientation relative to the supposed æther stream causes a change in the electric forces to which the cohesion of the molecules is ultimately due, so that if the temperature and the external stresses remain constant, the length changes. In this case, however, we cannot detect the change directly, as it would be necessary to turn our standard scale also, and it, too, would change. If for any reason the change of length is prevented, the FitzGerald-Lorentz effect causes a change of stress.

Now in the case of the rotating wheel the ratio of the circumference to the radius must remain constant, so that any tendency of one to change its dimensions will affect the other, with the result that both circumferential and radial stresses will be set up, and any changes of length caused must be compatible with the constancy of π. These stresses would in any actual case be almost vanishingly small compared with those due to centrifugal force, so that the only effect of the FitzGerald-Lorentz contraction would be to alter the latter stresses to an utterly negligible extent.

HORACE H. POOLE.

Physical Laboratory, Trinity College, Dublin, March 19.

Moseley Memorial.

THE fund founded in the University of Manchester for the provision of a memorial to the late H. G. J. Moseley (killed in action at Gallipoli, 1915), and originally proposed as a private memorial from Moseley's personal friends and fellow-workers in Manchester, has now been extended in order to give other scientific bodies, both in England and abroad, an opportunity of participating. This extension has been made at the request of a number of scientific men interested in Moseley's work, but not personally connected with him, and it is in order to reach this wider public that you are asked to publish this letter.

The scheme of memorial proposed is (1) the provision of a memorial tablet in the physical laboratory and (2) the foundation of a Moseley prize or medal for physics in the University of Manchester.

The fund is administered by a committee consisting of Sir Henry A. Miers (chairman), Profs. W. L. Bragg and H. B. Dixon, Sir E. Rutherford, and Dr. E. J. Evans.

Subscriptions, which should be made payable to the "Moseley Memorial Fund," and crossed "Williams Deacon's Bank, Ltd.," may be sent to either of the hon. secretaries, Mr. C. G. Darwin, Christ's College, Cambridge, or Dr. H. Robinson, Physical Laboratory, University of Manchester.

About 170*l.* has already been received, comprising donations from Great Britain, Canada, the United States, and France (including contributions from the Société Française de Physique and the Société de Chimie-Physique).

It is desired to close the fund in July of this year.

HENRY A. MIERS, Chairman.
C. G. DARWIN,
H. ROBINSON, Hon. Secretaries.

The Aurora of March 22–23.

I HAD a fine view of this superb display at Workington between midnight and 1 o'clock a.m., in a clear and bright starlit sky. The whole sky was filled with the light except a small area in the south-east. I could detect no colour except creamy-white, the general intensity being, to my mind, at times equal to full moonlight. Curtains of light surrounded a point just east of the zenith, which seemed to mark the "hub" of the display. The bright star (α) in Canes Venatici almost exactly marked this point, and filmy sheets of light seemed to dash upwards from the south-west and north-east horizons and merge together at this star. The only display I have ever seen to equal this was on 1907 February 14 at Motherwell, in the previous sun-spot maximum period. It was the fact that I could see the great sun-spot train on March 22 without telescopic aid that made me expect and look out for the aurora that night.

W. B. HOUSMAN.

Seaton Cottage, Workington, April 9.

The Nitrogen Problem: By-products.[1]

IT is surely high time that we, as a nation, were more fully alive to the necessity of a complete investigation of the recovery of by-products, and that not merely in connection with nitrogen products. There is still too much of the feeling—one comes across it quite frequently—that so-called waste products form a recognised loss in any process. The investigation of the treatment of any waste product is not looked upon as the work of the person engaged in the specific manufacture from which that waste product is obtained. Competition becomes keener as the years pass, and if our position is to be retained by-products must be recovered in all cases where such recovery can be economically effected. A waste product may even become the starting point of a new industry. The detailed investigation of the position as regards nitrogen by-products manufacture comes as a very welcome record and as a much-needed indicator of the forward path.

The world's ammonia production, in terms of sulphate, advanced between the years 1903 and 1913 from 540,200 long tons to 1,389,790, an increase of more than 150 per cent. The chief producers were Germany, the United Kingdom, and the United States, who were respectively responsible in 1913 for 39, 31, and 12½ per cent. of the total production. The essential sources are gas-works, coke-ovens, gas-producers, shale-works, iron-works, and bone, etc., carbonising works.

In the years 1911 and 1913 the coke-oven industry was responsible for 84 and 86 per cent. respectively of the German production, in 1913 for 78 per cent. of the United States production, and in 1911 and 1913 for 27 and 30 per cent. of the United Kingdom production. The United Kingdom production rose from 233,664 long tons in 1903 to 432,618 in 1913, of which, in 1903, gas-works provided 149,489 long tons, or 64 per cent. of the total, which steadily increased to 182,180, or 42 per cent. of the total. Coke-ovens in the United Kingdom provided in 1903 only 17,438 tons, or barely 7½ per cent., but continual increase brought up the amount by 1913 to 133,816 tons, practically 31 per cent. of the production of the country. Iron-works during this period retained a steady output of 19,000 to 20,000 tons, shale-works production increased gradually from 37,353 to 63,061 tons, and that of producer-gas, bone, etc., carbonising works from 10,265 to 33,605 tons.

These are illuminating figures which deserve consideration and show plainly the development of the by-product industry up to the commencement of the war period.

In addition to supplying home demands for ammonia nitrogen, there was an average yearly export of ammonia, ammonia salts, and products made therefrom during the years 1911 to 1913 equivalent to 82 per cent. of the total home production. This would have been more than sufficient to provide the nitrate and nitric nitrogen required for all purposes had the means of conversion been available, which they were not, so that we were dependent on imported nitrates for various purposes, including agriculture, the manufacture of sulphuric acid, nitric acid, explosives, and other products.

Passing on to the war period, estimates for the year 1917 indicate a by-product ammonia increase of 130 per cent. in the United States, 27 per cent. in Germany, and only 6 per cent. in the United Kingdom; but Japan has in the meantime taken a considerable step forward and increased her output more than sixfold—from 8000 tons in 1913 to 50,000 tons in 1917. The production of sulphate from coke-ovens in the United States had increased by 1916 to 83 per cent. of the total output, and in the United Kingdom to more than 36 per cent. of the total. Even during 1915 and 1916 considerably more than half our production of ammonia nitrogen was exported, and we were using large quantities of imported nitrate, all of which might be produced economically by ammonia oxidation or by synthetic processes, details of which are fully discussed in the report. We have now arrived at the stage where synthetic manufacture begins to complicate the ammonia problem and the economics of the various processes require the closest attention.

With regard to post-war conditions, it is certain that agricultural demands will be much greater than formerly: many lessons were learnt during the war, not the least being that of the need for increased food production at home. The consumption of combined nitrogen practically doubled during the ten years preceding the war, and there is little doubt that the increase will continue, nitrogenous fertilisers being more and more in demand, especially now that much more land is under cultivation than in pre-war days; in fact, our own agricultural demand for fixed nitrogen in the form of sulphate of ammonia and nitrates was more than doubled during the war period only. Moreover, nitric nitrogen will be needed in increased quantities owing to the extension of chemical manufactures, such as dyes and drugs, which hitherto have been too much neglected; and with this will be involved the oxidation of by-product ammonia.

It would appear likely that the world's productive capacity should now be able to provide some 30 to 40 per cent. more combined nitrogen than in 1914, and this does not appear to be greater than would have been the case under normal conditions had the ordinary rate of growth in consumption in the pre-war period been maintained during the four years under consideration.

Now, if food production in this country is to

[1] "Ministry of Munitions of War. Munitions Inventions Department. Nitrogen Products Committee. Final Report." Pp. vi+357. (London: H.M. Stationery Office, 1919.) Cmd. 482. Price 4s. net. See also NATURE, January 22 and 29.

be rendered independent of imported nitrogenous fertilisers, as is surely desirable—and recent conditions have shown that it may at any time become even absolutely necessary—and if this is to be coupled with a continued large export trade in nitrogen products, we must have a considerably increased production of ammonia nitrogen.

So far, practically all the by-product nitrogen has come from the manufacture of coal-gas, producer-gas, coke, and shale-oil; two possible sources have been practically untouched, viz. peat and sewage, though from the latter, owing to our position, perhaps little may be expected—certainly so unless some simple method should be discovered for recovering the soluble nitrogen from very dilute material. At the same time, it may be pointed out that the estimated annual amount of nitrogen in the sewage of the United Kingdom is 234,900 metric tons, 86 per cent. of which is in urine.

Power cost is, of course, the great factor in the question of by-product recovery *versus* synthetic manufacture, and this is affected by coal cost: the problem is fully discussed in the report. But questions of the first importance to the by-products industries, which must strive to increase production, are such questions as the efficiency of work on existing processes, the modification and further development of such processes, and the introduction of new methods.

Reviewing the gas industry, it is seen that, with existing methods, an increase in the amount of sulphate of ammonia recovered should certainly be expected. Many small gas-works run to waste the ammonia liquor, chiefly owing to their isolated position; a proposal is made in the report to work up liquors at small works in travelling sulphate plants, but this has been attempted in several instances and afterwards abandoned. One would remark, however, that some small works might well adopt the direct system of recovery, which has in some cases served very well, and a local demand for the sulphate produced would obviate cost of transport. A general consideration of the direct method of recovery demands more attention than has been given to it; much has been done and published in recent years by the Chief Alkali Inspector. Storage of ammoniacal liquor still needs attention; there are in use inefficient methods of running ammoniacal liquor into imperfectly covered wells and tanks: this point is strongly indicated in the report. In dealing with concentrated ammonia liquor, the losses are apt to be particularly heavy. It is considered that several thousand tons of sulphate might be added yearly to the gas industry ammonia recovery by attention to such matters as these. Moreover, it will be necessary to produce a somewhat higher grade and at the same time a neutral sulphate. But a question that demands perhaps even more attention is the introduction of new methods whereby the sulphur content of the gas itself would be made available, and so transport and use of sulphuric acid avoided. The Burkheiser and Feld processes still require to be worked out satisfactorily, and quite recently comes the proposal of Cobb to use sulphate of zinc as a starting material. These methods are perhaps all the more worthy of careful investigation owing to modern developments in the manufacture of coal-gas; the increase in the vertical retort method of carbonisation, coupled with steaming, has given rise to increased quantities of liquor of decreased strength.

In the metallurgical coke industry many of the bee-hive plants have disappeared in recent years, and this has, of course, had its effect on the ammonia production. There is now no longer any question as to the relative merits of bee-hive and by-product oven coke, and proper treatment might lead to an increase of 10 per cent. or more on the present total production of ammonia from all sources.

In the producer-gas industry, again, there is scope for investigation; scarcely sufficient stress appears to be laid on producer-gas practice as regards steaming and liming. Hydrated lime certainly has a quite appreciable effect on ammonia production, and it would seem, moreover, to admit of greater latitude in the choice of the coal used.

It is unfortunate that peat has not received more attention in this country; apart from nitrogenous by-products, some of the by-products from peat gasification appear to have quite a special value, judging from results obtained in Scotland and Ireland. Moisture and transport are, however, difficulties, yet schemes for the utilisation of peat on the spot might well be considered from a power point of view, even though the addition to the by-product nitrogen production would not be by any means of the first order.

A Survey of National Physique.[1]

ONE of the more valuable after-results of the great wars in the last century was the increased interest aroused in regard to national physique, leading to various measures directed towards its improvement. After the Napoleonic wars there arose the great gymnastic clubs of Central Europe and Scandinavia, which laid the foundations of physical education on a wide scale. The Civil War in America led to the first great demographic survey, the data of which were rendered public in the report of the Surgeon-General of the Federal armies on the statistics of the recruiting bureaux. The War of 1870 was followed by surveys of the population in Germany, and on a smaller scale in France, which to a large extent

[1] Ministry of National Service 1917-19. Report, vol. i., upon the Physical Examination of Men of Military Age by National Service Medical Boards from November 1, 1917-October 31, 1918. Pp. iv+159+charts. (London: H.M. Stationery Office, 1920.) Price 6s. net.

formed the basis of our ethnographic knowledge until the present time. The South African War led to the Commission on Physical Deterioration in England and Wales, and to a similar Commission on Physical Education in Scotland, from the labours of which resulted the introduction of medical inspection and treatment of school children, and perhaps in part also the National Health Insurance Act.

The Report of the Ministry of National Service on the Physical Examination of Men of Military Age by National Service Boards contains a survey which in extent, in wealth of demographic detail, and in narration of the associations of inferiority of physique surpasses all previous efforts in this country, and is approached elsewhere, as yet, only by the report of the American Surgeon-General's Department mentioned above. If similar data could have been collected from all examinations from the commencement of the war, a practically complete survey would have been available for the use of future social hygienists. It is probable that the earlier figures are irrecoverable, which may mean that while we shall in the future be equipped with a knowledge of the nature and sources of physical failure, we shall have fewer data as to the measure of physical fitness among the better-endowed members of the community. The anthropologist will thus derive rather less from the report than the social economist and hygienist.

The first volume of the report, which is all that is, as yet, issued, contains a brief introduction; sections on grading as a criterion of health, the comparison of grading results, the relation of occupation and health, the causes of low grading and rejection; and regional reports from the district Commissioners. Under each head there is a series of statistics chiefly taken from special areas, but an analysis of all available observations on physique and disabilities is promised for the second volume, which is stated to be in active preparation, and will present a complete survey of the conditions in Great Britain. The data available are taken from nearly two and a half million examinations, on a carefully standardised uniform system, the subjects being classified into four grades. Owing to re-examinations, the actual numbers of individuals would be slightly smaller save in the case of those rejected as totally unfit for service.

Grade 1 consists of those who attain to the full normal standard of health and strength, and are capable of enduring physical exertion suitable to their age. They have no progressive organic disease or serious disability or deformity. These constituted 36 per cent. of the total.

Grade 2.—Those who fall short of Grade 1 by reason of partial disabilities amounted to between 22 and 23 per cent.

Grade 3.—Those who presented such marked physical disabilities or such evidence of past disease as to be deemed unfit to undergo the degree of physical exertion required for the former, but including those fit only for clerical or sedentary work, amounted to 31–32 per cent.

Grade 4.—Those permanently and totally unfit for any form of military service numbered 10 per cent.

The proportions found in the different grades varied from time to time and from place to place according to whether the numbers coming up for examination consisted largely of older categories and those who had been rejected previously, or of those just attaining military age and those just combed out from previously protected occupations. In the main the distribution is in accordance with probabilities, with the average, however, not, as might have been hoped, among the fit, but among those with partial disabilities.

Prof. Keith submitted a comment on the earlier reports of the boards showing that on the basis of the average man being fit 70 per cent. ought to be in Grade 1, 20 per cent. in Grade 2, 7½ per cent. in Grade 3, and 2½ per cent. in Grade 4. In practice there is a grave deficit from this, though the results of examinations of certain groups, as of miners from the western part of the Welsh coalfield and of miners and agriculturists from Yorkshire during the period of the combing, showed that this theoretical standard was attained by the best of the community. Bearing in mind the physique of many who went to military service in the earlier years, and of many who remained to the end in protected occupations, the total deficit of the country is probably less than would appear from the figures in this report, yet enough is shown to indicate the need for ameliorative measures.

Prof. Keith points out that from every area, or at least from numerous and representative sample districts, there should be not only the full return of grading, but also frequency tables of stature, weight, and chest dimensions, so that anomalies in grading may be manifest and the nature of the deterioration in physique detected. He suggests that indices of fitness should be determined and shown on maps, which could then be compared with maps of other physical and social data. The indices he suggests are an index of efficient fitness or the percentage of Grade 1 men, and an index of average fitness to be derived by assigning 1 unit to each Grade 1 man, ¾ unit to each Grade 2, ½ unit to each Grade 3, and ¼ unit to each Grade 4, the whole being then added and expressed as a percentage of the total number of men examined. Many such data are given for isolated areas, so it is to be hoped that the maps may appear in vol. ii., when they will carry more conviction than tables or diagrams. Graphs of the frequency of the different gradings are given month by month for the areas, with, in the regional reports, some commentary on the classes examined. The total results show a relative inferiority in the southern part of the country.

The measurements recorded in this volume show an average for Grade 1 of 5 ft. 6 in. stature, 130 lb. weight, and 34 in. chest girth. The

general averages vary from area to area, but show, on the whole, a close similarity to those obtained by Roberts and by the Anthropometric Committee for the artisan classes some forty years back, though in this volume there are not enough data to enable the different areas to be contrasted on an ethnographic basis.

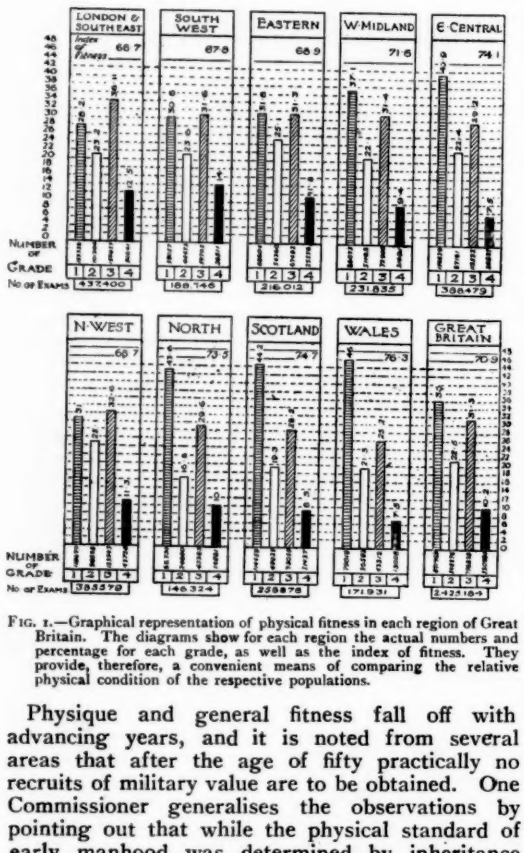

FIG. 1.—Graphical representation of physical fitness in each region of Great Britain. The diagrams show for each region the actual numbers and percentage for each grade, as well as the index of fitness. They provide, therefore, a convenient means of comparing the relative physical condition of the respective populations.

Physique and general fitness fall off with advancing years, and it is noted from several areas that after the age of fifty practically no recruits of military value are to be obtained. One Commissioner generalises the observations by pointing out that while the physical standard of early manhood was determined by inheritance modified by environment, above the age of forty, the determining factor was how a man had lived his earlier life.

The variation in physique with different occupations is very marked, as can be seen from the respective indices of fitness of groups, though it would perhaps be well to defer detailed comparison until full figures are available. The following may serve as illustrations :—

Occupation	Index of fitness	Per cent. in Grade 1
Munition workers and colliers, St. Helens	92·8	81·8
Colliers, Wigan	91·7	77·4
Colliers, West Wales ...	90·5	76·0
Agriculturists, Yorks	89·9	74·8
Engineers, Yorks	85·9	60·9
Iron and steel workers ...	85·7	60·2
Lace workers	77·4	45·0
Woollen trade	75·7	37·5
Tailors	69·5	33·9
Cotton operatives, Stockport	57·9	19·6

This is also seen by comparison of towns—*e.g.* in March, 1918, Sheffield showed an index of 83·3 with 61 per cent. in Grade 1, and Leeds an index of 62 with 14·5 per cent. in Grade 1. It is evident that the men of good physique are found in the heavier occupations. Among the causes of low grading, heart disease and tuberculosis take a high place, while in some areas there is a prevalence of infantile paralysis. Contrary to expectations raised by the recent campaign on public morals, the incidence of venereal disease as a cause of low grading is nearly negligible. A special series of charts shows the full data obtained as to the relation between occupation grading and disease in the London area. Sedentary occupations show the worst results, and it is a question whether in part it is not as much that those of inferior physique gravitate to sedentary work as that this in itself is harmful. Heart and circulatory disease, and to a less extent congenital or acquired deformities, constitute the chief causes of deficiency.

The information available in this volume is such as to require almost a separate description for each section, and the Ministry is to be congratulated on a volume which should be on the shelves of every social worker and reformer.

The Doctor of Philosophy in England.

THE neglect on the part of the English universities in not recognising a special faculty of philosophy has been remarkable, but this singular circumstance is of rare interest to the student of the history of universities. It is a curious fact indeed that the title of doctor itself dates, though with some uncertainty, to the first half of the twelfth century at Bologna, and to the middle of that century at Paris. About a century later the doctorate in law and divinity came into use in England, and in the fourteenth century followed that of medicine. In the fifteenth the English universities took the lead in conferring the degree of doctor of music. Yet doctorates in grammar, logic, and philosophy were given in Germany so early as the thirteenth century. Until comparatively recently the M.A. in England ranked above the Mus.Doc.

To those acquainted with the history and the evolution of degrees, that of master of arts must carry the greatest respect, if not veneration, from the point of view of antiquity, for it conveys with it the first traditions of the spread of learning in Europe, being as it is by far the oldest of degrees. The earliest teachers bore the titles of lord, master, and judge (*dominus, magister, judex*), which were in common use long before that of doctor. In fact, to this day the German

Ph.D. is primarily a master of arts, the degree being properly *Magister Artium et Doctor Philosophiae*, and is given for research, just as the Cambridge research M.A. is to-day. Whether the Cambridge research student who has already taken his M.A. will be qualified before long to add Ph.D. to his name remains, however, to be seen. Rashdall, in his "Europe in the Middle Ages," ridicules the practice now becoming prevalent in England of giving the master's and doctor's degrees in the same faculty; as, for instance, the LL.M. and LL.D. at Cambridge. Just as a doctor may have been learned in his own faculty, so was the master supposed to be supreme in his. In fact, the terms master, professor, and doctor were in the Middle Ages almost identical; and until Cambridge introduced the anachronism of the LL.M. in the nineteenth century, the master had always been regarded as equivalent to the doctor in his own special faculty. But the fusion of the two in Germany in the Ph.D. was in strict accordance with tradition, and perfectly correct.

It may be recalled that in England in the Middle Ages, as in Paris, teachers of law were styled doctors, and those of theology masters. The doctor of divinity, on the other hand, was a characteristic of Bologna, and the jealousy existing between the universities tended for some time to keep these features distinct.

In recent times, however, the doctorate has assumed a higher rank than the masterate. The University of Yale in 1860 first conferred the degree of Ph.D. after the German style, and this was followed by other universities in the United States. The commercial aspect of the question being of importance, there has been a strong tendency in recent years to recognise the disadvantages imposed upon students of research in this country, as compared with their rivals from Germany and the United States. For some time past—in fact, since 1895—Cambridge has given a Certificate for Research with the B.A. and M.A.—a distinction which is understood to rank with a first class in Part II. of the Tripos. This certificate testifies the candidate's dissertation to be "a work of importance and distinction as a record of original research." It is about the same standard as the German Ph.D. But the general public, being little acquainted with these innovations, continued to regard the Ph.D. as the hall-mark of respectability for all research workers, even in this country.

During the last year or two, however, Oxford, perceiving the need, has instituted the degree of D.Phil. for the benefit of those (*a*) who have attained the status of advanced student in the university, by having been placed in the first or second class in the Final Honours School, or in the first class in an Honours School of the First Public Examination, and passed all necessary examinations for the degree of B.A.; (*b*) students from other universities who have attained a similar standard, and can produce evidence of fitness to engage in research, having pursued a course of study at one or more universities extending over four years at least. After two years at Oxford, such students may, as a rule, apply for the D.Phil. by presenting a dissertation, which must constitute an original contribution to knowledge, set forth in such a manner as to be fit for publication *in extenso*, being, in the opinion of the examiners, of sufficient merit to qualify for the degree.

The example of Oxford has been followed by Cambridge. A new statute authorising the degree of doctor of philosophy for research has been approved by the Privy Council, and the regulations will be put before the Senate at the first Congregation in the Easter term. The statute will rescind the old regulations relating to research students. As in the case of Oxford, the status of an advanced student, known now at Cambridge as research student, must be attained, whether by graduates of Cambridge or by students from other universities. (*a*) A student, being a graduate of Cambridge, who has from the time of his admission as a research student pursued in the university, or in some other recognised place of study, a course of research for not less than three years, one year of which has been spent at Cambridge, and two either at Cambridge or at some other recognised place of study, may, not earlier than the ninth, and not later than the twelfth, term from his admission as a research student, submit a dissertation embodying the results of his research. (*b*) A student who, not being a graduate of the university, has kept by residence not less than six terms in a course of research, and pursued research for not less than three years, two of which have been at Cambridge, and one either at Cambridge or elsewhere recognised by the authorities, may, not earlier than his ninth, and not later than his twelfth, term as a research student, submit a dissertation embodying the results of his research. It is not quite clear whether, and if so what, provisions are made for those research students who have already taken the research M.A. having worked for the prescribed period at Cambridge or elsewhere.

At present a master of arts of five years' standing—that is, *twelve* years from matriculation—may apply for the Sc.D. The fee varies from twenty-five guineas to nearly 50*l.*, according to the college. But very few ever proceed to this, since by the time the necessary status is reached most men consider that they have had sufficient patronage and paid enough for their education to trouble about it. They are usually by that time tired of examinations and of submitting themselves to the criticism of examiners, some of whom, having remained at the university, holding small teaching appointments, may not have attained quite the same status in the outer world.

It is a matter of importance that examiners for such degrees should have the confidence of the candidates, as well as of the university authorities, as being at least their equals, if not superiors,

in the knowledge of the special subjects of the dissertations; for at some universities professors who have never published anything whatever are asked, as professors, to examine, for the doctorate, candidates with a European reputation! An instance of this nature has recently occurred in one of the universities in this country, the professors being almost unknown outside its walls. But no doubt Oxford and Cambridge may be trusted to stand above rendering such an injustice to those who seek their recognition and come from afar for the benefits they bestow.

British Crop Production.[1]

By DR. EDWARD J. RUSSELL, F.R.S.

FODDER and hay crops play a more important part than cereals in the economy of the farm, because they are the raw materials for a highly important part of the farmer's business—the production of meat, milk, or butter. They are too bulky to transport in any quantity, and farmers use only as much as they themselves grow. The output of meat and dairy produce is, therefore, limited by the quantities of these crops at the farmer's disposal. The quantities produced just before the war and in 1918 were:—

Production of Fodder and Hay Crops.

	Yield per acre 1908–17		Acreage. Millions of acres				Total produce. Millions of tons	
	England and Wales	United Kingdom	England and Wales		United Kingdom			
	tons	tons	1914	1918	1914	1918	1914	1918
Swedes	13·0	14·6	1·04	0·91	1·75	1·60	24·2	22·8
Mangolds ...	19·5 cwt.	19·5 cwt.	0·43	0·41	0·51	0·50	9·5	10·3
Hay (temporary)	29·1	32·2	1·55	1·45	2·90	2·80	4·2	4·4
Permanent grass	22·6	27·9	4·79	4·30	6·49	5·95	8·2	7·9

Like cereals and potatoes, these crops are greatly affected by artificial fertilisers, especially by phosphates, which increase not only the yield, but also the feeding value per ton. This is strikingly shown in the case of swedes and turnips, which receive a large part of the superphosphate made in this country. Mangolds respond remarkably well to potassic fertilisers and to salt. There is much to be learned from a systematic study of the influence of artificial manures on the composition and feeding value of these crops under the varied conditions of this country.

A further reason for the important part played by these crops in the economy of the farm is that they profoundly affect the fertility of the soil. They do not remove from the soil all the fertilising constituents which must be added to secure maximum growth; some of these constituents are left behind in the soil to benefit the next crop—a rare instance of double effectiveness for which the farmer ought to be profoundly thankful. In the second place, even the fertilising constituents which are absorbed by the crop are not entirely retained by the animal; considerable quantities are excreted and pass into the manure, and again are added to the soil. There is, therefore, the possibility of constant improvement of the soil; larger fodder crops enable more livestock to be kept, more livestock make more manure, and more manure gives still larger crops. It is sometimes argued that meat or milk production is in some way opposed to corn production, but on this method there is no antagonism; on the contrary, each helps the other. The production of more meat is consistent with, and indeed involves, the production of more corn.

The simplest way of utilising animal excretions without loss is to allow the animals to consume the crop on the land where it grows, and this is frequently done excepting where the soil is so sticky as to become very unpleasant in wet weather. Sheep are the best animals for the purpose, as they are easily penned in by light hurdles, these being moved as each portion of the field is cleared; this folding is a common occurrence on the chalky and sandy soils of the Southern and Eastern Counties.

Bullocks are less tractable, and cannot be enclosed by light hurdles; they are, therefore, generally kept in yards, roofed in if possible, but oftentimes open. Sufficient straw is added to provide them with bedding and to soak up the excretions. In this way the fertilising constituents of the straw as well as of the food are returned to the soil.

In the case of dairy cows the treatment is rather different; they have to be housed properly in quarters which are sometimes palatial, and for hygienic reasons they are allowed but little bedding. Their manure is removed once daily—sometimes oftener—the primary object being to get it away without contaminating the milk. The investigations already referred to for which Lord Elveden provides the funds are now being extended to the dairy farm to see how far it is possible to save the manure without prejudice to the purity of the milk.

In the old days, when farmyard manure was the only manure and the old type of implements alone were available, farmers had to arrange their crops on a definite plan in order to get through their work and maintain permanently the productiveness of the land. There thus grew up a system known as the rotation of crops, which contributed very largely to the agricultural developments of the 'sixties, and ultimately became a rigid rule of husbandry strictly enforced over large parts of the country. Modern cultivation implements and fertilisers justify much more latitude, however, and no good farmer ought to be restricted in his cropping, provided, of course, that he maintains the fertility of his land. It is sometimes a convenience on the dairy farm to grow the same crop year after year on the same land, and the Rothamsted experiments show that this can be done, excepting only in the case of clover. With this exception there is no more need to have a rotation of crops than there is to have a rotation of tenants in a house. It is essential, however, that the land should be kept free from other competitors and from disease germs. Freedom from competition means the exclusion of weeds. In the old days this had to be effected by periodical bare fallows. Nowadays a different course is possible; modern cultivation implements worked by a tractor allow great scope for the suppression of weeds. There is, however, one crop that must be grown periodically to ensure the best results—clover or a mixture of clover and grass. Clover affords valuable food for cattle during winter, and it also enriches the soil in highly valuable nitrogenous organic matter. Much of this is the work of the plant itself, and could equally well be done by grass; but the enrichment in nitrogen is the work of bacteria residing

[1] Discourse delivered at the Royal Institution on Friday, February 20. Continued from p. 178.

in the nodules in the clover-roots, and is unique among the phenomena of the farm.

Unfortunately, clover, unlike other crops, cannot be grown frequently on the same land, and, consequently, the farmer is unable to make as much use of it as he would like. Investigators have for many years been trying to increase the effectiveness of the clover organism, but without result. Inoculation of the soil with virulent strains has been tried, but it was unsuccessful in this country, although results are claimed in the United States. The problem has recently been taken up at Rothamsted, and one reason found for the previous failure. The organism has several stages in its life-history, one of which is a period of rest; some conditions favour a long rest, others a shorter one, and Mr. H. G. Thornton is endeavouring to find out how to increase the activity of the organism in the soil and ensure that its work shall be done. Attention is being devoted also to the causes of failure of the crop. The clover crop furnishes some of the most important problems in arable farming before us.

In the meantime, a working solution lies in growing an admixture of grasses with the clover. This reduces the risk of failure while considerably benefiting both soil and farmer.

A typical arable district is thus a busy region in which both farmers and workers are kept constantly occupied. The crops claim attention all through the year, and particularly in summer, while in winter the animals need attention. Four or more men can be regularly employed per 100 acres. An organised village life has developed, having distinctive characteristics of its own and presenting endless scope for the intelligent social worker.

Grass farming, on the other hand, stands out in sharp contrast with all this. The grass farmer puts his animals into the fields, and Nature does the rest; when they are fat he sells them to the butcher. It is essentially summer work; the winters are left free. As no man can long remain idle, there has been an extensive development of hunting and its attendant occupation, horse-breeding, in the English grass regions. While the grass farmer's life is not all idyllic joy, it is, at any rate, free from much of the worry and uncertainty of arable farming, and it brings in sufficient money to ensure a modest competence. One can quite understand the reluctance of the farmer to quit this path of safety.

If one could accept the doctrine that a man could do what he liked with his land, the grass farmer could be left alone and reckoned among Virgil's too happy husbandmen. But this doctrine is now somewhat out of court, and the needs of the community have also to be taken into account. From this point of view grass husbandry, in spite of its safeness for the individual farmer, is not so good for the community as arable farming, since it is less productive per acre of ground. This was realised before the war, and was vividly brought to the notice of farmers by Sir Thomas Middleton, who drew up the following table :—

Number of Persons who could be Supplied with Energy for One Year from the Products of 100 *Acres of*

Poor pasture converted into meat		...	2–4
Medium pasture	ditto	...	12–14
Rich pasture	ditto	...	25–50
Arable land producing corn and meat		...	100–110

The area of rich pasture is very restricted. An improvement can often be made in poor and medium pasture by the use of basic slag, by drainage, and in other ways, but the results could probably never surpass those now obtained on rich pasture. None of them approach the results obtained on arable land.

During the war, therefore, the policy of the Food Production Department was to convert grassland into arable, and much was done; but now that the element of compulsion has disappeared some of the arable is going back to grass. It is not that the farmer is trying to avoid work; he is impressed by the greater risk of arable farming,[2] and, above all, he desires to keep to the well-established principle that his system of husbandry must suit the local conditions. This is strikingly shown by the following returns from a large number of farms :—

Collected by the Agricultural Costings Committee.

	Income per acre			Expenditure per acre			Profit[3] per acre			Capital per acre		
England and Wales—	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Mixed farms ...	9	12	5	10	2	11	1	7	2	13	9	0
Dairy farms ...	14	17	0	13	18	5	1	7	4	15	7	0
Corn and sheep	7	7	1	7	4	10	1	14	2	12	10	9
Large sheep farm	1	4	3	0	17	6	0	8	5	1	7	10
All Scottish ...	5	10	9	4	15	10	1	4	11	7	7	9

The profit per acre from the large sheep farm is small in itself, but it is large in proportion to the capital and the expenditure, and, given a sufficient acreage, the farm is more lucrative than the more risky mixed or dairy farms. The risk of corn production can, and probably will, have to be met by some system of insurance or guarantee; but the need to conform to local conditions will always remain.

The problem therefore arises: Can a system of husbandry be devised which suits the natural conditions as well as grass, and is as productive of total wealth as arable crops? I believe this can be done. Grass is not the only crop adapted to moist conditions or heavy soils, and appropriate for the production of meat and milk. Many other leaf or root crops serve as well, some of which yield much more food per acre than does grass. Vetches, rape, mangolds, kale, and marrow-stem kale can all be used direct, and there are various mixtures of oats with peas, tares, vetches, etc., that can be fed green and made into hay or silage as the farmer may wish. The use of these crops in the place of grass for the feeding of livestock is known as the soiling system.

We are only just beginning to discover the combinations of crops best suited to particular conditions. An interesting experiment is in progress at the Harper Adams Agricultural College, which, however, should be repeated elsewhere. Each crop is governed by the same general laws as hold for cereals. In each case the yield and feeding value can both be increased by the proper use of artificial fertilisers, and there is the further possibility of great improvement by the plant-breeder.

It is in this direction that I think British agriculture will develop in the future. The system is strictly in accordance with the laws of science, and therefore it needs a minimum amount of artificial support. It gives the farmer abundant scope for the production of livestock, which he has always regarded as his sheet anchor, and the community an abundant production of food per acre. Most important of all, while

[2] On our ordinary farm at Rothamsted (distinct from the experimental land) the expenditure on arable land is continuously increasing, while that on the grassland is much less. The figures are :—

	1913-14			1917-18			1918-19		
	£	s.		£	s.		£	s.	
Wheat	5	7	...	10	14	...	14	0	
Oats	6	4	...	9	7	...	14	5	
Roots	17	10	...	20	18	...	36	0	
Potatoes	21	1	...	37	11	...	46	0	
Grass (hay)	3	19	...	4	16	...	6	0	
,, (grazing) ...	2	15	...	2	4	...	3	0	

Direct wage payments account for about 40 per cent. of the expenditure on arable land, but for less than 15 per cent. of that on grassland.

[3] Including change in valuation.

retaining the best features of our present arable and grass systems, it allows of considerable further development.

I shall not venture any opinion as to how far we could go in feeding ourselves. The accompanying table shows what we did before the war, and what, on our present technical knowledge, we could do now, assuming that the insurance problem of covering the extra risks of arable farming were solved, and assuming also a reasonable increase in the efficiency of labour.

In this country we can certainly hope to find the solution of the insurance problem, and I hope and believe of the labour problem also. Our output per acre of the arable crops is distinctly above that of many other countries, though we no longer lead as we did in the 'sixties. Our output per man, however, is not particularly good, and is open to considerable improvement. Those who know the agricultural labourer best have the fullest faith that his sterling qualities will enable him to rise to the new levels of industrial capacity which the man of science and the engineer have opened out for British agriculture. There are anxious days ahead, but with wise and sympathetic treatment the difficulties can be solved and our future assured.

Consumption and Production of Human Food in the United Kingdom. Million Tons per Annum.

	Consumption (1909–13)	Home production		
		Pre-war	1919[4]	Estimated attainable
Wheat, barley, and oats	13·4	6·5	7·0	10·0
Other cereals	3·5	—	—	—
Potatoes	5·5	4·8	6·3	7·0
Dairy produce	5·2	4·7		5·0
Meat	3·0	1·8		2·5

[4] Mr. McCurdy gives the following details for 1919 (see *Times*, February 18, 1920):—

Consumption and Production of Food in the United Kingdom, 1919.

Commodity	Estimated total consumption	Proportion of home-grown and imported produce included	
		Home-grown Per cent.	Imported Per cent.
	Tons		
Wheat	7,395,000	27	73
Barley	1,956,000	64	36
Oats	4,297,000	92	8
Beef and veal ...	995,000	66	34
Mutton and lamb ...	368,000	57	43
Bacon and hams ...	447,000	19	81
Butter	180,000	58	42
Cheese	145,000	30	70

Notes.—Cereals: The quantities are given after deduction for seed, and in the cases of wheat for tailings also. Bacon: The quantities given are for bacon as smoked or dried.

Obituary.

THE death of M. LUCIEN POINCARÉ, Vice-Rector of the University of Paris, on March 9, at fifty-eight years of age, will be felt as a great loss, not only to higher education in France, but also to the *entente* between the universities of that country and those of Great Britain. Only a fortnight before M. Poincaré came to England, accompanied by Mme. Poincaré, to open the British branch of the Office National des Universités et Ecoles françaises, housed with our own Universities of the Empire Bureau in Russell Square. His speeches on February 23, at the Bureau, and on February 24, at the University of London, where he was given a special reception, and at the Lyceum Club, left on his hearers a deep impression of charm, of width of knowledge, of sound judgment, and of sympathy. M. Lucien Poincaré, like his brother Raymond, former President of the French Republic, and his cousin Henri, the great mathematician, came from Lorraine. He was a physicist by training, and took his doctor's degree with a thesis on the resistance of fused electrolytes. Like most French physicists, he began his teaching career in secondary education, and was a master first at the Lycée of Marseilles, and then at the Lycée Louis-le-Grand in Paris. For a time he was *chargé-de-cours* at the Paris Faculty of Sciences; later he entered on an administrative career and held successively the posts of Rector of the Académie of Chambéry, of Inspector-General and then Director of Secondary Education, and of Director of Higher Education at the Ministry of Public Instruction. In October, 1917, M. Poincaré was appointed official head of the University of Paris (the most distinguished post in French university administration) in succession to the veteran M. Liard.

THE death is announced, at sixty-four years of age, of PROF. HECTOR TREUB, the eminent professor of gynæcology in the University of Amsterdam.

THE death of MR. H. S. B. BRINDLEY is recorded in *Engineering* for April 9 as having occurred on March 28, only three days before his name appeared on the list of newly created Knights Commanders of the British Empire. Mr. Brindley was born in 1867, and educated at the Tokio Engineering College, where his father was an instructor. He had wide experience with several engineering firms, and will be remembered chiefly by his energetic development during the war of a disused artificial stone factory at Ponders End into a shell and gun factory employing more than five thousand hands, a task which could have been accomplished only by a very exceptional man.

BY the death, lately announced, of MR. W. J. RAINBOW, the Australian Museum of Sydney, New South Wales, has lost the services of an entomologist who for twenty-four years laboured with assiduity and success to make the collection of insects and Arachnida in that institution worthy of a great colony, and has thereby laid all students of those classes under a lasting obligation. Mr. Rainbow's published works include treatises on certain groups of Lepidoptera and Diptera; but his main attention was given to the study, and especially the life-history, of spiders and scorpions. His papers on Arachnida are sixty-seven in number, one of the latest being devoted to a description and classification of the Araneidæ brought from Macquarie Island by the expedition under Sir Douglas Mawson.

Notes.

PROF. C. J. MARTIN, F.R.S., director of the Lister Institute of Preventive Medicine; Sir William Orpen, K.B.E.; and Sir J. E. Petavel, K.B.E., F.R.S., director of the National Physical Laboratory, have been elected members of the Athenæum Club under the provisions of the rule of the club which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

THE Royal Danish Society of Science has elected Sir Ernest Rutherford and Sir Joseph Thomson as fellows in the physical and mathematical class, and Sir George Grierson and Prof. W. M. Lindsay fellows in the historical and philosophical class.

DR. A. MCWILLIAM, formerly assistant professor of metallurgy in the University of Sheffield, and now a consultant metallurgist in that city, was invested by the King with the Order of C.B.E. on March 20. This honour was conferred upon him for his general war work in India, principally in connection with the supply of steel for war purposes.

As already announced, the Geological Survey and the Museum of Practical Geology were transferred from the Board of Education to the Department of Scientific and Industrial Research on November 1 last. The Lord President has now appointed a Geological Survey Board for the management of the work of the Survey and museum, and to submit from time to time recommendations on developments that appear to be necessary as the work progresses. The Board, as at present constituted, consists of Sir Francis G. Ogilvie (chairman), Prof. W. S. Boulton, Prof. J. W. Gregory, Dr. John Horne, Prof. J. E. Marr, Mr. Frank Merricks, and Mr. W. Russell.

SIR HENRY HOWORTH has presented to the Geological Department of the British Museum (Natural History) the collection of mammalian and other remains obtained by Mr. W. J. Lewis Abbott from a fissure near Ightham, Kent. This collection is especially important on account of the care with which the bones of the small animals were extricated and preserved. The ordinary larger specimens belong to the woolly rhinoceros, mammoth, reindeer, stag, roe-buck, horse, and hyena, and show that the greater part of the fauna at least dates back to the latter part of the Pleistocene period. All the circumstances of the discovery were discussed by Messrs. Abbott and E. T. Newton in the Geological Society's Quarterly Journal in 1894.

DR. CARLOS AMEGHINO, director of the Argentine National Museum, announces that he has recently discovered the oldest known remains of man at Miramar, near Mar del Plata, on the coast of the province of Buenos Aires. Human remains were found in the same district several years ago in association with stone implements and with bones of the extinct Toxodon and ground-sloths; but according to the observations of Dr. Aleš Hrdlička and Dr. Bailey Willis (Smithsonian Institution, Bureau of American Ethnology, Bulletin 52, 1912), they are of no great antiquity, and probably represent a modern South American race. All the supposed discoveries of early man in America have hitherto proved unsatisfactory, and Dr. Ameghino's detailed report on the latest find will be awaited with interest.

CAPT. VAUGHAN-WILLIAMS, who is excavating the supposed site of Edward the Confessor's palace in Windsor Great Park, has discovered what is believed to be the dedication-stone of a Saxon place of worship. Upon the stone are the marks of a cross and what looks like Saxon lettering. Among other discoveries are the remains of a kitchen and banqueting-hall and the traces of what seem to be Roman baths. This confirms the statement of Mr. Forestier that the palace of the Saxon king was built upon the site of a Roman villa, which was provided, as usual, with a series of baths. The remains of the chapel indicate that it was 40 ft. long, and, according to Bishop Browne, who recently inspected it, it contained an altar for the worship of God, and one smaller for the worship of devils.

NINETEEN years ago the splendid survivor of the Great Trilithon at Stonehenge was in a very dangerous condition, but it was set upright again, and now the Office of Works, in association with the Society of Antiquaries, is engaged in restoring to a position of safety other stones that are in danger. A question of interest has been raised during the work now in progress. Just inside the Ditch a circle of holes has been discovered in the chalk, which mark the site of an outer circle of stones. In these holes have been found charred human bones, bits of burnt animals' bones, or only a single tine of a stag's horn. Aubrey's map, made in 1666, showed in approximately the position of these newly found holes a series of depressions in the turf which have since then disappeared. In one was shown a stone which has since been removed. The detached stone, well known as the "Slaughtering Stone," which lies in line with the "Hele Stone," appears to fit almost exactly into place in this new circle. Whether it is the last survivor of an outer circle of stones, and whether this outer ring was coeval with Avebury and made before Stonehenge itself existed—these are questions which cannot now be answered until further excavations help to solve the problem.

THE James Forrest lecture for the present year will be delivered at the Institution of Civil Engineers by Sir Dugald Clerk at 5.30 on Tuesday, April 20. The subject will be "Fuel Conservation in the United Kingdom."

THE fourth Guthrie lecture of the Physical Society of London will be delivered on Friday, April 23, at 5 o'clock, by M. C. E. Guillaume, who will take as his subject "The Anomaly of the Nickel-Iron Alloys: Its Causes and its Applications."

SIR GEORGE NEWMAN will deliver the Lady Priestley memorial lecture of the National Health Society on Thursday, April 22, at the Royal Society of Medicine.

His subject will be "Preventive Medicine: The Importance of an Educated Public Opinion."

THE Wilbur Wright lecture of the Royal Aeronautical Society for the present year will be delivered on Tuesday, June 22, at the Central Hall, Westminster, by Comdr. J. C. Hunsaker, U.S.N., who will take as his subject "Naval Architecture in Aeronautics."

UNDER the auspices of the National Union of Scientific Workers a public meeting, presided over by Mr. H. G. Wells, is to be held at 8 o'clock on Wednesday, April 28, in the lecture-theatre of Birkbeck College, Breams Buildings, E.C.4, addressed by Prof. F. Soddy on "The Public Support of Scientific Research." The address will be followed by a discussion.

THE Scottish Shale Oil Scientific and Industrial Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The association may be approached through Mr. W. Fraser, C.B.E., Scottish Oils, Ltd., 135 Buchanan Street, Glasgow.

A COMMUNICATION has been received from the Decimal Association criticising the recent report of the Royal Commission on Decimal Coinage. The association maintains that the report cannot be accepted as final for the following reasons, among others:—The Commission ignores the fact that eleven of our Colonies or Dependencies have already adopted decimal coinage, and that our non-decimal Dominions have repeatedly advocated the establishment of the decimal principle in currency. Further, the report exaggerates the difficulties which would be caused by the abolition of the penny, and takes no account of the altered and daily decreasing purchasing power of that coin. The Decimal Association considers that the first minority report represents the actual opinion of the community, and that the decision given in the main report is short-sighted and unpopular. For these reasons the association intends to persist with its active propaganda in favour of the reform.

IN *Ancient Egypt* (part i., 1920) Prof. Flinders Petrie describes the hoard of personal ornaments found some ten years ago at Antinoe, in Upper Egypt. Unfortunately, the hoard was not preserved intact, and the valuables are now scattered in London, Berlin, Detroit, and the Pierpont Morgan collection. The greater part of the treasure, now described by Dr. Dennison, is dated by coins to the time between Justinian and Mauricius Tiberius, the latter half of the sixth century. The finest object is a great necklet with fourteen inserted coins from Theodosius to Justinian, and a barbaric imitation of a gold coin of Valentinian III. as a centre-piece, the taste for making imitations of coins for ornament being familiar in North Europe. Prof. Petrie attributes the dispersal of the collection to the present Egyptian law of treasure-trove. If the Government would pay, as dealers do, the local prices, collections could be purchased much below the value in Europe, and the profit would go to the State, not to the dealer.

THE probability of the Norse discovery of Spitsbergen before the voyage of Barents in 1596 is the subject of an article by Dr. F. Nansen in *Naturen* for January–February, 1920. It has long been a matter for discussion whether the Svalbard of the Icelandic annals was Spitsbergen, and the weight of evidence favours the belief that it was. Dr. Nansen reproduces an Icelandic map published in the sixteenth century, before Barents's discovery, which certainly suggests that Svalbard was the coast of Spitsbergen. At the same time, it does not preclude the possibility of its identification with north-eastern Greenland; but this explanation is improbable, in view of the courses given for reaching Svalbard from Iceland. Dr. Nansen believes that the Norsemen found Svalbard by chance, some vessel having been driven out of its course by a gale. He thinks that the greater attraction of the fisheries on the coast of Norway, particularly the Lofoten Islands, diverted attention from Svalbard, which was eventually forgotten. There is no evidence whatever that Barents made any use of Norwegian knowledge in his voyage in 1596. The article contains a good reproduction of the map known as Barents's chart, published in 1599 by Cornelius Claesz.

A WELL-KNOWN and much-advertised institute of mind-training has sent us particulars of a laboratory of applied psychology which it has organised and equipped. For a specified fee the laboratory, it is stated, "will enable those who need vocational guidance to discover with scientific accuracy their strong and weak points, and to obtain expert advice on the choice of a career. . . . Those living at a distance can have tests forwarded by post." Vocational psychology is the youngest branch of the youngest of the sciences; it is not ten years since the publication of the well-known books by Taylor and by Münsterberg upon industrial psychology and so-called scientific management. Many, therefore, will doubt whether any laboratory can yet state the vocational qualifications of a given individual "with scientific accuracy" either by post or otherwise, much less whether an institute organised for profit is the proper place for such investigations. At the same time the new venture is a striking testimony to the advance made by psychology, both during and since the war, into fields of practical application; and, clearly and ably written as they are, the two pamphlets issued by the new laboratory, on "Choosing a Vocation" and on "Choosing Employees," may do useful service in acquainting both employers and applicants for employment with the possibility of scientific method in vocational guidance, and with the probability that, when established by disinterested research, such methods will be as superior to the current methods of personal preference or of phrenological advice as the prescriptions of a properly qualified medical specialist are superior to the pills of a wise grandmother or the potions of a local herbalist.

WE have on several occasions referred to articles in the *Cologne Post*—a daily paper published by the

Army of the Rhine—on educational institutions and work connected with the Army of Occupation. The first number appeared on March 31, 1919, and a copy of the anniversary issue reached us a few days ago. The journal has been most successful, and is exerting a very valuable influence in revealing British thought and spirit to Germany. It has a large circle of German readers, and is used in many schools for reading lessons and the study of English. "Here," says an editorial article in the anniversary number, "in this great German city we bide, facing a wonderful land torn with dissensions after the mightiest conflict of all time; we of the *Cologne Post*—a little band of soldier scribes—and, never forgetting the ravaged west which lies behind us, we are facing east, where the sun rises." To the staff which is thus promoting a better understanding between two peoples we offer our most cordial congratulations upon the success of their faithful and intelligent work. It is particularly appropriate that we should associate ourselves with other good wishers in this expression, because Capt. W. E. Rolston, the editor and manager of the *Cologne Post*, was, before the war, a constant contributor to our columns. He was formerly an assistant to Sir Norman Lockyer in the Solar Physics Observatory at South Kensington, and when the observatory was transferred to Cambridge he went with it. For several years he wrote the whole of the notes in Our Astronomical Column, and also contributed numerous articles and reviews. Capt. Rolston provides another example of the value of a scientific training to business management and literary balance, and his devoted attention to what is really a unique newspaper merits the fullest official recognition.

In a study of the colour and markings of pedigree Hereford cattle (*Journal of Genetics*, vol. ix., No. 3) Miss F. Pitt finds that the breed arose by selection from the nondescript cattle of the county during the seventeenth and early eighteenth centuries. All sorts of colours and markings prevailed, but among them the red with white face, which is still characteristic of the breed, was most common. This pattern probably originated through a mutation which appeared in a dark herd in 1750, and was kept and bred from as a curiosity. The white face is a dominant condition, while excessive white in modern Herefords is found to be recessive to the typical pigmentation. Variations from type which now occur in the breed are due to the outcrop of recessive characters inherited from the time before pattern selection was practised.

Considerable foliage injury is reported in Michigan owing to the substitution of calcium and magnesium arsenates for lead arsenate for spraying purposes. The Quarterly Bulletin of the Michigan Agricultural College Experiment Station (vol. ii., No. 2, November, 1919) reports interesting tests carried out to discover the reasons for this injury. Plants in respiring give out considerable quantities of carbon dioxide, with which the film of moisture on the leaves is presumably charged. The tests show that calcium and magnesium arsenates are very much more soluble in carbonated water than in pure water, while for lead arsenate the reverse is true. It seems, therefore, that this solubility of calcium and magnesium arsenates in carbon dioxide is the cause of the foliage injury occurring in fruit-trees sprayed with these materials. It is suggested that the addition of lime to the spray mixture may prevent the injury, but this suggestion awaits proof.

As the result of comprehensive tests carried out by the New South Wales Department of Agriculture on two of their experimental farms, it is claimed that a more satisfactory method has been found of treating seed-wheat for bunt than by pickling in a bluestone solution. According to *Science and Industry* (Australia), carbonate of copper gives the best results, as has been shown after many years of experimenting with other substances. The method which the investigators recommend is to dust dry copper carbonate through the grain at the rate of 2 oz. of the fungicide to one bushel of wheat. Substantial increases in the yield per acre were obtained in comparison with pickled seed, while other advantages which the new process possesses over established practice are said to be that (1) no water is necessary; (2) no injurious effect is caused to either the grain or the young plant, as is the case with bluestone pickling; (3) seed-wheat can be treated weeks before it is sown; (4) no damage is done to the grain if it should lie in a dry seed-bed for weeks without germinating; (5) better germination is obtained; and (6) the process is quicker and less laborious than wet pickling.

An Official Guide has been issued (143 pages, price 2*s*.) to the Museum of British Forestry (Museum No. 4) at the Royal Botanic Gardens, Kew. This museum, which was opened in 1910, occupies Cambridge Cottage, formerly the residence of the Duke of Cambridge. The term "forestry" is more correctly used as synonymous with sylviculture—that is, for trees and shrubs that are grown for commercial purposes—the term "arboriculture" being used for trees and shrubs that are grown as specimen plants or for purely ornamental work. The objects in view in the production of the two types of trees are very different, and the mature specimens differ in appearance. The scope of the museum is at present limited to collections of timber, fruits and seeds of trees, dried specimens of a few types of hardy trees and shrubs, photographs of isolated trees and plantations, the fungus- and insect-diseases of trees, articles manufactured from British-grown timber, and tools and machinery used in sylvicultural and arboricultural operations. In most instances the specimens shown have been grown, manufactured, or collected in the British Isles. Room No. 3 contains a series of special interest to the student, and illustrates the trees and shrubs native to or planted in Great Britain, with a brief account of their economic uses; the arrangement is according to the natural families. Injuries to trees caused by various agencies—animals, parasitic or climbing plants, fungi, and insects—are also illustrated in detail. Apart from its service as a guide to the museum, the booklet contains much

useful information on our British-grown trees and their economic value.

ATTENTION may be usefully directed to the high grade of Indian bauxites now under development, as represented by analyses given by Dr. L. L. Fermor in his article on "The Mineral Resources of the Central Provinces" (Rec. Geol. Surv. India, vol. l., p. 273, 1919).

DR. HOLTEDAHL'S interesting maps and discussion of the distribution of land and water in the North Atlantic region in Palæozoic times (see NATURE, vol. ciii., p. 433) have been reproduced for readers of English in the *American Journal of Science* for January (vol. xlix., p. 1). Some corrections have been noted in the separate copies sent out by the author, the most important being the accidental exchange of the titles of Figs. 9 and 11, which should be rectified by those who may use them in their reissued form.

IN a paper on "Old Age and Extinction in Fossils" (Proc. Geol. Assoc., vol. xxx., p. 102, 1919) Dr. W. D. Lang directs attention to the reluctance—perhaps better called indifference—of the female to the reception of the male animal, as exhibited, for instance, by mosquitoes, as a possible cause of extinction of a group. He applies this possibility to the ammonites; but his main thesis is that extinction may result from exaggeration of a structure on the removal of an inhibiting influence. Environment may thus be effective, but the tendency in the organism is, on the whole, superior to external influences in affecting evolution and decadence. The increase in deposition of calcium carbonate in the Cretaceous cheilostomata, and the "exhaustion of their ancestral potentialities" in the case of the rugose corals, are utilised as examples in a discussion that would obviously bear expansion.

SCIENTIFIC Paper No. 363 of the Bureau of Standards (Washington) just to hand deals with the manner of preparation and determination of the spectral reflective properties of certain alloys of aluminium with magnesium and with zinc by R. G. Waltenberg and W. W. Coblentz. The investigators found that all these alloys tarnish in time, and hence are not suitable for mirrors where permanency is of the first importance. The compound of aluminium and magnesium, Al_2Mg_3, deteriorates less rapidly than any of the other alloys examined, and could be used in apparatus where a highly reflecting mirror is desired for a short time. A reflectivity of 92 per cent. at $0{\cdot}7\mu$ was obtained with this compound. The zinc-aluminium alloy has a minimum reflectivity at $0{\cdot}9\mu$. An examination of the reflectivity of pure zinc revealed a similar reflectivity minimum at $0{\cdot}1\mu$.

IN a paper on "The Development of the Atomic Theory," by A. N. Meldrum, of the Bombay University, published by the Oxford University Press, a plea is put forward that historical questions should be made the subject of serious investigation and discussion, and should be taught in the universities by those who have given special attention to them. The paper is devoted very largely to vindicating the view that the atomic theory was not originated as a pure novelty by Dalton, but was a legitimate development of Newton's views. Attention is directed to the importance of Newton's theory of the repulsion of gaseous particles in the theoretical views of Bryan Higgins, William Higgins, and Dalton. Thus Bryan Higgins suggested that ammonia and hydrogen chloride must unite particle with particle, and in no other way, since if two particles of ammonia attempted to combine with a single particle of acid, one of them would be driven away from the acid by the mutual repulsion of the two particles of ammonia. William Higgins, for the same reason, assumed that, since like atoms repel one another, the most stable combination of dissimilar atoms is in the ratio 1:1, then 2:1, and then 3:1. This view did not attract so much attention as it deserved, but was identical with the method used by Dalton in deducing the formulæ of compounds. It is suggested that Dalton did not necessarily borrow his views from Higgins, but that both workers, starting from Newton's doctrine of an elastic fluid composed of mutually repulsive particles, followed much the same train of thought and reached essentially the same conclusions.

PROF. AIMÉ WITZ, professor of physics at Lille University, contributes a well-reasoned article on heat economy to the issue of the *Revue générale des Sciences* for March 15. He reviews in turn the merits of steam-engine and turbine plants, internal-combustion engines, and electric power distribution from the point of view of thermodynamic efficiency. As regards the reciprocating steam engine, he counsels caution in the replacement of this method of heat utilisation by turbo-electric plants in small works, and cites figures to show that the *generic* efficiency of the former may be extremely favourable under certain conditions. Much progress has been effected in recent years in the design of exhaust steam turbines, and in certain cases it may be very desirable to run a low-pressure turbine off the large cylinder of a multiple expansion steam engine of the reciprocating type, and thus effect a better yield per pound of steam expended. On the wider (national) question the author devotes considerable space to the subject of the gasification of coal at the place of production and its direct utilisation for power purposes, with the recovery of by-products, the gas generated being used for running large gas engines, and the heavy residual oils for internal-combustion engines of the Diesel type. In this connection he gives some figures showing the very satisfactory results obtained at certain mines in France from installations run from coke-oven gas, supplemented by steam units, for power purposes. Finally, he reviews the claims for a national electric network, comprising a number of single and self-governing units combined to meet all the possible demands of industry. The paper is well worthy of study by all who are interested in the better utilisation of our fuel resources.

Our Astronomical Column.

CONJUNCTION OF JUPITER AND NEPTUNE.—On the morning of April 20 these planets will be within 1° of each other; the actual distance at 4 a.m. will be 0° 55′, Jupiter being on the north side of Neptune. Jupiter will set at 2.37 a.m. The motion of the two objects is so slow that in the earlier hours of the night of April 19 their relative positions will be but slightly different from that at the time of conjunction on April 20 at 4 a.m. Neptune will be situated in Cancer about 2¾° east-south-east of the star cluster called Præsepe and 1½° east of the star δ Cancri. Neptune may be easily picked up in a good telescope, but is not brighter than about eighth magnitude. To identify this faint object if the small stars north of Jupiter are unknown requires that the observer should make a diagram of the objects in the field of the telescope and compare it with later observations in a few weeks' time. At the period of conjunction Neptune will be stationary.

A NOVA IN A SPIRAL NEBULA.—*Ast. Nach.*, 5038, contains a note by Prof. Wolf on the discovery of a nova in the faint spiral nebula N.G.C. 2608 (position for 1860, R.A. 8h. 26·7m., N. decl. 28° 56′). The nebula is shaped like the letter S; the star is near the left-hand point of the upper curve. There are two nuclei, of which the north preceding is the brighter. The nova is 18·6″ from this nucleus, in P.A. 280°. It was discovered on a plate taken on February 8 last, and was afterwards found to be registered faintly on plates taken on January 25 (near edge of plate, bad image) and February 7. Plates taken in previous years were examined, and showed no trace of the star; a small nebular condensation was, however, visible in the neighbourhood. The latest available plate was taken on 1918 February 5.

Short exposures were secured of the nebula on February 11 and 12; the nova appeared brighter visually on the former date. On the latter its photographic magnitude was 10·7. A sketch-map of the field is given in *Ast. Nach.*, with magnitudes of comparison stars. It is important to obtain good light-curves of these novæ in spirals, as they sometimes give a clue to the absolute magnitude of the star, and hence of the distance of the spiral. The region will be observable for the next two months.

Observations on March 10 gave the magnitude of the nova as 11·5.

THE MADRID OBSERVATORY.—The "Anuario del Observatorio de Madrid para 1920," in addition to the usual almanac information, particulars of the sun-spots and prominences in 1918, and meteorological observations, contains a useful article by Señor C. Puente on methods of determining time and latitude by means of portable instruments in the field. Special attention is directed to the circumzenithal telescope designed by Nušl and Frič, of Prague, which consists of a small horizontal telescope which can be rotated in azimuth. A silvered prism with vertical angle α is mounted outside the object-glass; the upper face reflects light from a star of altitude $180°-\alpha$, the lower face light from the same star after reflection by a very small mercury trough. Coincidence of the two images is observed in the telescope, and gives the instant when the star's altitude is $180°-\alpha$. There are some advantages in making this angle equal to the latitude, but this is not essential. Tables are given facilitating the construction of working catalogues. Observations of several known stars make it possible to deduce both time and latitude. The instrument is similar to the almucantar in theory, but far more portable and easier to work with. The absence of all webs and screws is a decided advantage.

National Education.

THE fiftieth annual meeting of the National Union of Teachers, founded in 1870, at which some 2000 delegates were present, representing a membership of 113,000 as compared with 400 on its formation, was held during Easter week at Margate. The proceedings were opened by a well-timed and thoughtful address on the part of the new president, Miss J. F. Wood, of the Fielden School, Manchester (herself a pioneer in the endeavour to bring opportunities of advanced secondary education within the reach of children leaving school during their fourteenth or fifteenth year), in which she reviewed the history of popular education since the Act of 1870, recounting its onward progress and making clear the objects still to be achieved, to ensure which all the various classes of teachers should make a common effort and present a united front. The Act of 1918, with which the name of Mr. Fisher will be linked in honour for all time, provides for fuller opportunities of education for elder children in elementary schools, for their easier transfer to higher schools by means of maintenance grants, for closer attention to conditions of physical health and education, and especially for the continued part-time education up to eighteen years of age of adolescents entering industrial life at fourteen.

The president pleaded for a more unified conception of education if these objects are to be attained and the full value of education to the nation is to be realised. Every child capable of profiting by advanced courses of education and training, whether given in higher or special schools or in the universities, should be afforded the fullest facilities. Wherever possible the elementary school should be enlarged in scope, with freedom to develop its own "top," and so obviate the necessity for the establishment of the central school with its futile two-year course. The further education of adolescent workers should have careful consideration, and, having regard to the mechanical nature of much of their work, also have in view the claims of leisure. With the purpose of fitting the primary teacher for all branches of education service, including the administrative, he should in all cases, in addition to appropriate professional training, be also required to take a university degree. The claim of women to be afforded equal opportunities with men to aim at the highest in the career they enter and with the same reward was firmly stressed. The future progress of education depends not only upon more suitable buildings, adequate playgrounds and equipment, and smaller classes, but also upon the supply of able and well-educated teachers, who must be attracted first by the nature of the work, and then by adequate pay, status, and prospects. There should be ensured also the full co-operation of the Board of Education, the local education authorities, and the teachers with the view of securing full partnership in administration, and, above all, of winning for all children a free and liberal education.

Among the many important topics discussed during the conference, reference may be made to that dealing with a national system of education, which received the full assent of the conference, and embodied proposals for (1) free education for all to the fullest extent of their capacity to profit by it; (2) the provision of maintenance grants where necessary; (3) the due co-ordination of schools, so that graduation from one to another of higher type shall be easy; (4) uniform regulations for all schools in respect of size of classes, adequacy of staff, floor- and air-space, playing grounds and fields, and swimming baths; (5) medical examinations, and treatment where neces-

sary; (6) the right of any qualified teacher to teach in any capacity in any State-aided school; (7) no class in any type of school to exceed thirty on the roll, and each class to have its own qualified teacher; and (8) the curriculum of the primary school should be liberal and non-vocational, with the aim of promoting true citizenship and high personal character. It was also suggested that the attention of public opinion and of organisations representing parents of elementary-school children should be directed to the powers now possessed by persons interested in education to secure substantial improvements in the educational facilities provided in their localities by means of representations on the schemes prepared by local education authorities under the Act of 1918, where such schemes fail to attain the standard set up in the foregoing proposals, and that county and local teachers' associations should stimulate the demand for the full benefits of the Act of 1918 in each locality.

A further important topic discussed at the conference was "The Supply and Training of Teachers." The scheme submitted was approved by the conference, and included the following main requirements: (1) All intending candidates should have completed a satisfactory course of higher education, and show by adequate tests their fitness for the profession; (2) the admission to the graduate course should be the standard of matriculation; (3) the course of study should include "Education" as a principal subject for the degree, and the course be followed in association with other students entering for other professions; (4) a period of one year should, as a rule, be devoted to the acquisition of skill in teaching, the existing training colleges (which should be recognised as colleges of the university) being utilised for this purpose alone, whilst education research work should be a distinct feature of the college staff and students; (5) on the completion of the academic and professional training the teacher should be eligible for recognition by the Board of Education for service in any approved school; and (6) the teachers of special subjects should be required to take a course of higher education and of professional training.

Aeronautics at the Imperial College.

SIR RICHARD GLAZEBROOK, the occupant of the Zaharoff chair of aeronautics at the Imperial College of Science and Technology, completed on March 24 the series of five lectures which initiate the new course of study. It will be remembered that Sir Basil Zaharoff founded similar chairs in Paris and in Petrograd. The London chair has been chosen by the Government as the nucleus around which to organise a central school of aeronautics—a scheme in which the new professor's long experience as Director of the National Physical Laboratory, chairman of the Advisory Committee for Aeronautics, and, latterly, chairman of the Government Committee on Education and Research in Aeronautics, will be of immense help. In the years to come the courses of instruction so provided will doubtless prove of service to officers of the Royal Air Force selected by the Air Ministry for higher technical training, in addition to such numbers of other students as the then position of civil aviation may inspire to join this new and adventurous profession.

The attendance at this initial course of lectures must have been encouraging to the lecturer, if only as an indication of a widespread general interest in the subject. In the circumstances, the lectures were, naturally and rightly, of a simple character, only the last one, on air-screws, being at all technical.

Sir Richard Glazebrook in his first lecture paid a tribute to the munificence of the founder of his chair, and proceeded to a description of the experimental wind-channels and of full-scale experiments on aircraft. He was able to show how, on Lord Rayleigh's law of similarity, the measurements made by the one method could be compared with the other. The agreement in most cases was reasonably satisfactory, though enough anomalies had been found to provide an ample field for future research work. This was followed by a lecture on the principles of automatic and inherent stability. The former is achieved by the use of auxiliary apparatus, whether mechanical or aerodynamic, to operate the controls of the machine; and the latter by providing, in the original design, such sizes and positions for the aerodynamic surfaces that any departure of the machine from its normal position brings into play forces which tend to restore it to that position, and create a "damping" couple sufficient to prevent the continuance of such oscillations. Inherent stability can, as experience has amply shown, be provided for by careful design, so that automatic apparatus for the purpose is quite unnecessary. Commercial machines should be decidedly stable, fighting machines only just stable. Sir Richard Glazebrook was able to show (with Mr. Nayler's assistance) a number of mica models in flight, and so to illustrate the various forms and degrees of stability and instability.

The third lecture was concerned with the instruments essential to flight, and included the air-speed indicator, the engine-revolution indicator, the altimeter, the clinometer (to indicate side slip), the statoscope (to show the rate of climb), and the turn indicator. The statoscope measures the rate of air leakage through a small hole in a vessel kept at a constant temperature. Turn indicators are of two forms, the static head type and the precessional gyro type; these are later inventions than the other instruments mentioned.

Among the most important measurements made on an aeroplane are the determinations of oscillation in yaw, roll, and pitch; for such experiments use can conveniently be made of the sun as a fixed point, since the motion of a shadow of some part of an aeroplane on the rest of the machine can be employed to obtain a photographic trace of the oscillations. This work, however, is really only just beginning.

In view of the enormous inertia forces which come on a machine when "stunting," it is essential to obtain a continuous record of their amount during all parts of the flight-path concerned. For this purpose a stiff fibre acted as an acceleration index, and some most valuable records were obtained. On occasion the force on the wings of the machine might be three, or even four, times the weight of the aeroplane.

This naturally led in the fourth lecture to a consideration of the strength of the wing structure and to statements of the load factors necessary in design. The load factor is the ratio of the breaking load to the normal load corresponding to horizontal straight flight at the designed speed. Another important coefficient is the factor of safety, and this is the ratio of the breaking load to the loading incurred during some specified operation, *e.g.* a vertical nose-dive. The load factor needs to be fixed at a higher figure for machines which, like fighting machines, have to "stunt."

Sir Richard Glazebrook's fifth and last lecture was of special interest. The subject, "Air-Screws,"

is intricate, and not one in which it is easy to excite interest in a general audience. It is, therefore, much to the lecturer's credit that he succeeded in making the subject not only intelligible, but also interesting. He discussed first Froude's theory of the screw, and then showed how the various factors in the resulting equations had been checked by experimental work both in the wind-channel and on the "rotating arm" apparatus. Incidentally, he referred to the flapping flight of birds, showed how difficult it would be to imitate this, and doubted whether true progress lay in this direction. Mankind had made much use of the wheel in mechanism; evolution had led to the introduction of no such element in animal life, in spite of its proved efficiency in its many human applications. This afforded an argument that man had here beaten uninstructed Nature. The only flying animal which approached the aeroplane in design was perhaps the beetle, which possibly used its horny wing-covers as stationary planes and its wings as a means of propulsion.

The Parallaxes of Globular Clusters and Spiral Nebulæ.

IT may be remembered that Dr. Charlier expressed doubt as to the correctness of the enormous distances for globular clusters announced by Dr. Harlow Shapley. Mr. Knut Lundmark, of Upsala Observatory, undertook a re-examination of the question, taking different lines of evidence from those used by Dr. Shapley. His work is published in *Kungl. Svenska vetenskapsakademiens Handlingar*, Band 60, No. 8. His data are avowedly of a much less precise character than those used by Dr. Shapley, but they lead to results of the same order of magnitude:—

(1) The discussion of the proper motion of those clusters for which data are available indicates a value not exceeding 1″ per century. Accepting this maximum value, and combining it with the mean radial velocity of clusters found by Prof. Slipher, Mr. Lundmark finds the distance 3000 parsecs, one-fifth of Dr. Shapley's value.

(2) Use is made of Kapteyn's luminosity law. Van Schouten has already applied this method to the clusters M3, 5, 11, and 13, obtaining distances that are, in the mean, twenty-eight times those of Dr. Charlier and one-eighth of those of Dr. Shapley. His work is here revised, estimation being made of the spectral type of the stars from Dr. Shapley's observed colour-indices. The mean of several independent estimations gives 6000 parsecs for the distance of M3 and M13.

(3) A rough estimate of distance is made from the observed mean absolute magnitudes of stars of different spectral types. Various assumptions are made as regards the mean spectral type of the stars employed. In the mean the distances found are about eighty times those of Dr. Charlier, or one-third of those of Dr. Shapley.

(4) Holetschek has investigated the apparent magnitudes of several clusters regarded as single objects. Mr. Lundmark shows that his values are about 7½ magnitudes brighter than Dr. Shapley's mean values of the twenty-five brightest stars in the respective clusters, this difference being very nearly constant.

It follows that the assumption that the absolute magnitude of a cluster is constant will lead to relative distances of the different clusters proportional to those deduced by Dr. Shapley.

The four lines of evidence outlined above, though individually weak, have cumulative force, and tend to increase confidence in the accuracy of Dr. Shapley's work.

Mr. Lundmark uses Prof. Slipher's radial velocities of clusters to determine the sun's motion with regard to them. He finds that its velocity is 381 km./sec. towards R.A. 320°, N. decl. 74°. He notes that both the R.A. and declination of the solar apex as determined from stars tend to increase as fainter stars are used. This is explained by a larger proportion of the stars being outside the local cluster. He suggests that his value is the limit to which the others are tending.

Mr. Lundmark passes on to consider the parallaxes of the spiral nebulæ.

(1) Beginning with the Andromeda nebula, he quotes all the directly observed measures of its parallax. They are discordant, but their mean is near zero.

(2) The star density increases towards the middle of the Andromeda nebula, in spite of the nebulosity tending to veil them. It is concluded that the nebula is more distant than the non-nebular faint stars in the region. A combination of the results of many workers indicates a distance of 3000 parsecs for these faint stars.

(3) A combination of measured angular rotation of spirals with the values of the linear rotational speed given by the spectroscope has led to estimates of distance somewhat greater than the last, say 4000 parsecs. It is further shown that the mass necessary to control the rotation is $10^9 \times$ sun, of the same order as the estimated mass of the stellar system.

(4) Making the rather doubtful assumption that the dark curves in various nebulæ have the same absolute dimensions as the similar dark regions in the galaxy, Wolf finds distances for various spirals ranging from 10,000 to 200,000 parsecs.

(5) Comparisons of the light curves of novæ in spirals with those in the galaxy, while they involve several rather doubtful assumptions, give very large distances for the spirals, 200,000 parsecs being found for the Andromeda nebula. Bullialdus noted that the Andromeda nebula was exceptionally bright in the year 1664. It is conjectured that a nova of magnitude 5 or 6 may have appeared in it at that time.

From the above and other considerations Mr. Lundmark locates the spiral nebulæ far beyond the galactic limits, but inclines to the view that they are the star-producing mechanisms of Mr. Jeans's theory rather than counterparts of the galaxy. Their linear dimensions appear to be much inferior to the latter, of which our ideas have lately been enlarged by Dr. Shapley's and other researches.

The Forestry Commission.

WE are informed that the Forestry Commissioners who were appointed on November 29 last at once proceeded with the planting programme for 1919–20. The shortage of forest-tree seed has been met to a great extent by purchases in Austria and elsewhere and by gifts from the United States and Canada. About 34,000 acres of afforestable land are in course of acquisition by purchase or on lease, in some cases below the market value and in others as free gifts from landowners. Rather more than 10,000 acres are in England, of which 3500 are in Suffolk, 2760 in Devon, 1150 in Cumberland, and 1800 in Northamptonshire and Bedfordshire. More than 5000 acres are in Ireland, of which 2000 are in Tyrone, 1500 in County Galway, 1500 in King's County, and

the remainder in County Cork. The remaining 18,000 acres under acquisition are in Scotland. Planting is proceeding at thirteen centres—six in England and Wales, six in Scotland, and one in Ireland. Statistical work is being carried out and preliminary surveys are being undertaken.

The scheme for advances under the Forestry Act will be published after the consultative committees which have just been set up have considered the proposals.

Forest apprentices are receiving a two-year course in the Forest of Dean, the New Forest, and in Chopwell Woods, near Newcastle, and additional schools will be opened during the year. A special course for men with previous forestry experience is being conducted at Marischal College, Aberdeen.

An Imperial Conference to consider the forest resources and policy of the Empire is being organised for July, when a number of persons interested in forestry are expected in this country for the British Empire Timber Exhibition. The conference is expected to lead to the establishment of an Imperial Bureau of Forestry Information.

The Commission has published Bulletin No. 1, "Collection of Data as to the Rate of Growth of Timber" (which can be obtained post free for 4½*d.* on application at the headquarters of the Commission, 22 Grosvenor Gardens, London, S.W.1); also Leaflet No. 1, "Pine Weevils" (free). Other publications will follow at an early date.

The four consultative committees under the Forestry Act have been appointed, and consist of the following members:—

England.—Lt.-Col. G. L. Courthope (chairman), Col. M. J. Wilson (vice-chairman), Sir J. Ball, Lord Henry C. Bentinck, E. Callaway, the Earl of Chichester, M. C. Duchesne, J. H. Green, W. A. Haviland, Sir Edward Holt, Bart., E. C. Horton, A. F. Luttrell, W. Peacock, Major Harold Pearson, Col. B. J. Petre, Thomas Roberts, Sir William Schlich, W. R. Smith, Charles Stewart, Sir Lawrence Weaver, Col. J. W. Weston, and Leslie S. Wood.

Wales.—The Lord Kenyon (chairman), Col. F. D. W. Drummond (vice-chairman), C. B. Bovill, Major David Davies, Alderman T. W. David, Col. J. R. Davidson, Capt. J. D. D. Evans, Col. W. Forrest, Vernon Hartshorn, G. A. Humphreys, C. Bryner Jones, J. Jones, Lt.-Col. W. N. Jones, Col. C. V. Llewellyn, F. J. Matthews, the Earl of Powis, L. R. Pym, D. C. Roberts, J. Roberts, Major-Gen. A. E. Sandbach, J. I. Storrar, the Lord Tredegar, H. C. Vincent, P. Wilkinson, and Col. Sir H. L. Watkin-Williams-Wynn, Bart.

Scotland.—Sir Hugh Shaw-Stewart, Bart. (chairman), Gen. Stirling of Keir (vice-chairman), the Right Hon. William Adamson, Sir Isaac Bayley Balfour, F. R. S. Balfour, Wm. Black, Gilbert Brown, J. C. Calder, Sir Isaac Connell, J. A. Duthie, G. Fraser, R. Galloway, S. J. Gammell, Sir Robert Greig, J. H. Milne Home, G. Leven, Sir Robert Lorimer, H. L. Macdonald, Sir Kenneth J. Mackenzie, Bart., J. T. McLaren, J. Matson, D. Munro, Major W. Murray, J. Scott, and J. Wight.

Ireland.—T. B. Ponsonby (chairman), H. De F. Montgomery (vice-chairman), E. M. Archdale, J. Bagwell, the Lord Osborne Beauclerk, R. Bell, R. Bradley, S. Brown, J. R. Campbell, St. Clair M. Dobbs, Sir Henry Doran, J. Everett, V. C. Le Fanu, Wm. Field, A. C. Forbes, J. Calvin, the Earl of Granard, Prof. Augustine Henry, Wm. Kirkpatrick, A. E. Moran, the Viscount Powerscourt, the Viscount de Vesci, A. Vincent, Capt. R. H. Prior Wandesforde, and the Right Hon. F. S. Wrench.

Recent Fishery Investigations.[1]

FIVE years ago the pivot round which fishery investigation turned was the question of the productivity of the North Sea grounds. It was agreed that the enormous development of catching power since the last third of the nineteenth century had produced no apparent change in the abundance of herring, haddock, whiting, and possibly some other species, but that, on the other hand, plaice, sole, turbot, and some other edible fishes had been affected. In January, 1913, the Plaice Committee of the International Fishery Council stated that it then had evidence that large plaice were becoming scarcer in the North Sea, and that small plaice were becoming more abundant, and this was taken to be proof that there was "impoverishment," or excessive exploitation of a natural resource. The conclusion is not free from ambiguity, for, on the whole, the *total quantity* of fish landed increased up to 1913; what had happened, it appears, was a reduction in the average expectation of life of a plaice living in the North Sea. Now if that change was a result of "intensive" fishing up to 1914, what has been the result of the very great decrease in fishing during the years 1915–18? Drs. A. C. Johansen and Kirstine Smith seek to answer this question by discussing measurements of plaice landed from a Danish North Sea area which was tolerably free from military restrictions during the period of war. They find that the pre-war tendency has been reversed; that large plaice are now relatively much more abundant than they were, but that their rate of growth has decreased—a curious result. We were justified, they say, in concluding that intensive fishing could reduce a natural stock of fish, and we are also justified in expecting that a slackening of this intensity of fishing, even for a relatively short period, will have the opposite effect.

The method by which the latter conclusion is made is indirect, and one is scarcely convinced that it is beyond doubt. It seems easy to show whether or not a natural fishery is stationary or declining. It would be easy and the conclusions certain if the systems of collecting statistics were adequate and well planned and if there were good scientific investigations that enabled one to interpret the statistical data. But the statistics are not adequate, and the scientific investigations have been neither well planned nor properly supported, and therefore the methods are roundabout ones and the conclusions do not carry absolute conviction. We do not know, for instance, that there is not a natural periodicity of abundance and that the results noticed do not simply represent phases in a cyclic change. It is quite likely that they do.

The last report of the Dove Marine Laboratory (at Cullercoats, Northumberland) contains an account (by Mrs. Dorothy Cowan and Mr. B. Storrow) of investigations into the local herring fishery. This and former reports contain a very rich series of data with regard to the biology of the herring on the North East coast, and apparently not all the results obtained have been published—the present report, for instance, deals only with age-determinations (by means of "scale-readings"), while biometric measurements made as part of the Board of Agriculture and Fisheries scheme of racial investigations have also been accumulated. Prof. Meek, in editing the report, points out that extensive accumulations of data have not yet been analysed, and that such treatment is advisable before further investigations are planned. His discussion of some of Mr. Storrow's results gives point to an expression of dis-

1 "Meddelelser fra Kommissionen for Havunder sogelser; Ser Fiskeri," Bd. v., Nr. 9. (Copenhagen, 1919.)

appointment that the numerous inquiries and conferences held during the past year have not yet had any result. Local investigation with regard to the movements of herring shoals is insufficient. In this case the shoals leave Northumbrian waters and appear later on off the Firth of Forth, where, apparently, they are not sampled or investigated. It is therefore regrettable, Prof. Meek suggests, that reconstruction should have been a departmental rather than a national affair.

J. J.

Flora of the Hawaian Islands.

THE natural history of the Hawaian Islands has been well worked as regards both the flora and the fauna. Generally speaking, there is an extraordinary degree of endemism in the plants and animals, associated with a strong Southern Pacific or Australasian and Indo-Malayan affinity and a weak Northern Pacific or American affinity. The islands are extremely isolated, being further removed from any continental area than is any other region of equal size upon the globe. The nearest continent is North America, two thousand miles away, and the nearest islands of any importance, the Marquesas, are 1860 miles distant. Within forty miles of the shores the ocean exceeds 10,000 ft. in depth, and between the islands and the American coast reaches in places more than 20,000 ft. The most commonly accepted view of the origin of the archipelago is that the islands, which are entirely volcanic, were raised by volcanic activity, and that they have always been completely isolated.

In a paper entitled "The Derivation of the Flora of Hawaii" (Leland Stanford Junior University Publications, University Series, 1919) Prof. D. H. Campbell gives a *résumé* of the composition of the flora and its relations to American and Southern Pacific floras generally, and criticises unfavourably Guppy's view of its origin and distribution. Guppy accepts the view that the archipelago has always been completely isolated, and that air-currents and birds have been the agents concerned in its population. The predominantly Australasian and Indo-Malayan element was, he suggests, introduced largely by birds, especially fruit-eating pigeons, but Prof. Campbell finds a serious objection in the absence of such birds from the present fauna, as, apart from a number of American migratory shore-birds, practically all are endemic. Prof. Campbell strongly supports the view taken by Mr. H. A. Pilsbry, based on the study of the molluscan fauna. The land-snails are all ancient types the modern representatives of which are largely confined to Polynesia, and they represent, it is contended, an ancient fauna which has survived from a time when Hawaii was part of a continental area connected to the south-west with that of Polynesia. A study of the insects leads to a similar general conclusion, namely, that while the ancestors of some of the species may have been introduced through the agency of wind- or ocean-currents or by migratory birds, there are many more species of both plants and animals the presence of which can best be explained by a former more or less direct land-connection between Hawaii and the Indo-Malayan region.

The multitude of islands constituting Polynesia are, on this hypothesis, the remains of a once extensive land-mass, either a single continent or several large continental islands like Australia. This great area has been subsiding since Early Tertiary times, and the existing islands are the tops of mountain masses, often volcanic, superimposed upon this submerged continental area. A serious objection to this theory is the absence in Hawaii of certain types of vegetation characteristic of Southern Pacific regions, such as the conifers, aroids, and figs, and it is suggested that these forms became extinct after the isolation of the islands. Similar examples of such disappearance of plants are afforded by Sequoia, Liriodendron, and other genera, which had once a wide distribution, but are now represented in many regions only by Tertiary fossils.

University and Educational Intelligence.

DR. J. B. CLELAND, of the Health Department of New South Wales, has been appointed to fill the newly constituted chair of pathology in the University of Adelaide, South Australia.

APPLICATIONS for grants from the Dixon Fund, of the University of London, for assisting scientific investigations, are receivable by the Academic Registrar, University of London, South Kensington, S.W.7, until May 14 next. They must be accompanied by the names and addresses of two referees.

THE MARQUESS OF CREWE, chairman of the governing body of the Imperial College of Science and Technology, and Sir Alfred Keogh, Rector of the college, will attend the annual dinner of the Old Students Association of the Royal College of Science, to be held at the Café Monico on Saturday, April 24. Other distinguished guests will be Prof. W. H. Bragg, Dr. W. Garnett, Sir Richard Glazebrook, Mr. W. McDermott, and Sir Ronald Ross. Tickets (price 10*s.* 6*d.*) may be obtained from Mr. C. S. Garland, acting secretary, Old Students Association, Royal College of Science, South Kensington, London, S.W.7.

AT a general meeting of old students held recently at King's College, Strand, it was decided to form a King's College, London, Old Students' Association for the purpose of promoting social intercourse and of keeping the members in touch with their old college. The association hopes to include students from all faculties, and the subscription of 10*s.* 6*d.* per annum will include the *King's College Review*, published once a term, and a list of members with their addresses (and possibly the work on which they are engaged). Further particulars and forms of application for membership may be obtained from Miss M. A. V. Fairlie, hon. secretary, 3 St. Julian's Farm Road, West Norwood, S.E.27.

Societies and Academies.

Faraday Society, March 1.—Dr. T. Martin **Lowry** and F. C. **Hemmings**: The properties of powders. The caking of salts is, in general, dependent on the presence of a solvent, usually water. The following cases have been studied: Nitrates, other anhydrous compounds, hydrated salts, loss of sulphur dioxide during caking, and contraction during caking of copper sulphate.—Dr. T. Martin **Lowry** and **S. Wilding**: The setting of dental cements. Phenomena of caking or setting may be divided into five classes:—(1) Recrystallisation of anhydrous or hydrated salt without change of chemical composition. (2) Formation of hydrates. (3) The hydrolysis of complex salts by water. (4) The formation of new salts, such as the magnesium oxy-cements and the zinc oxy-phosphate cements used in dentistry, and "silicate" cements. (5) Amalgams in which mercury takes the place of water.

Zoological Society, March 16.—Prof. E. W. MacBride, vice-president, in the chair.—R. I. **Pocock**:

External characters of the South American monkeys. The paper showed the variations in the range of structure of the ears, nose, hands, feet, and external genitalia.—Dr. C. F. **Sonntag**: The comparative anatomy of the tongues of the mammalia. Having first outlined the plan which would be followed in his series of comparative studies, the author proceeded to describe the different divisions of the tongue and the physical characters of each. He demonstrated by diagrams and lantern-slides the different forms which the papillæ and openings of Wharton's ducts can assume among the mammalia, and exhibited specimens illustrating the shapes and colours of the tongue and the arrangements for cleaning the teeth.

March 30.—Dr. A. Smith Woodward, vice-president, in the chair.—Dr. C. F. **Sonntag**: Abnormalities of the abdominal arteries of a young panda.—A. **Loveridge**: East African lizards collected in 1915–19, with description of a new genus and species of skink and a new sub-species of gecko.

Royal Meteorological Society, March 17.—Mr. R. H. Hooker, president, in the chair.—Capt. C. K. M. **Douglas**: Clouds as seen from an aeroplane. A large number of photographs of clouds taken from an aeroplane were shown, nearly all of which were taken by the lecturer while flying in co-operation with the Meteorological Section, R.E., in France in 1918–19. The primary object of the flights was to obtain the temperature in the upper air for the artillery and for forecasting, and advantage was taken of the opportunity to study cloud-structure and its relation to the upper-air temperature and humidity and to the general meteorological conditions. The observations were made at Berck, on the French coast, twenty miles south of Boulogne, which lies close to the most important aerial routes. The photographs showed a large variety of cloud-forms, and also some changes which took place in short periods. A number of the photographs showed thunderclouds. Thunderstorms are caused by powerful ascending currents, and the tops of the clouds grow up to a great height, frequently exceeding 20,000 ft. Often when the weather is overcast and gloomy there is brilliant sunshine within one or two miles of the ground, and the clouds viewed from above present a splendid spectacle.

PARIS.

Academy of Sciences, March 8.—M. Henri Deslandres in the chair.—G. **Humbert**: An extension of the modular group in an imaginary quadratic body.—F. E. **Fournier**: Forms of hull of least resistance to their translation in free air at all velocities.—C. **Guichard**: A characteristic property of congruences belonging to a linear complex.—P. **Vuillemin**: Remarks on a fungus attributed by M. Loubière to the genus Trichosporium.—Sir James Dewar was elected a correspondant for the section of general physics in succession to the late Prof. Blaserna.—J. **Villey**: The adaptation of internal-combustion motors to high altitudes.—B. **Gambier**: Surfaces of translation applicable to each other.—M. **Fréchet**: A complete family derived from the family of ensembles "*bien définis*."—P. **Humbert**: Functions of the parabolic hypercylinder.—M. **Renaux**: A problem of iteration.—J. K. **de Feriet**: An application of generalised differentials to the formation and integration of certain linear differential equations.—L. **de Pesloüan**: The extension of the rule of L'Hôpital to certain arithmetical quantities.—J. **Chazy**: The impossible singularities of the problem of n bodies.—H. **Blondel**: Application of the method of Lagrange to the orbit of the planet discovered by M. Comas Solà, January 13, 1920.—E. **Belot**: A new form of the law of distances of planets and satellites resulting from the spiral formation of the planetary system, and the cause of rotation of the planets.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the third quarter of 1919. Observations taken on eighty-nine days are summarised in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—L. **de Broglie**: The calculation of the limiting frequencies of K and L absorption of the heavy elements. A comparison of the numbers deduced from Bohr's theory and from Végard's formula with the average experimental data derived from the experiments of Végard, Siegbahn, and de Broglie. The results for the L bands for tungsten, platinum, gold, lead, bismuth, thorium, and uranium are clearly in favour of Végard's formula.—M. **Rennesson**: The loss of energy in the dielectric of commercial cables. Two sets of experiments are described: in the first the frequency and temperature were maintained constant, and the voltage varied; and in the second the temperature was the variable, voltage and frequency being constant. In the latter case the energy losses in the dielectric showed a minimum at 30° C.; the losses at 30° C. were about half those found at 12° C. or at 55° C.—A. **Caillas**: The search for invertin in pure honey. The presence of invertin in pure honey was definitely proved, and this explains why two analyses of a sample of honey made at different times may give different results for the sugars present.—J. **Martinet** and O. **Dornier**: The azo-compounds of indoxyl.—Ch. **Boulin** and L. J. **Simon**: The preparation of methyl chloride and bromide starting from dimethyl sulphate. The interaction of concentrated hydrochloric acid and methyl sulphate gives pure methyl chloride; methyl bromide is obtained in a similar manner by substituting a solution of an alkaline bromide acidified with dilute sulphuric acid for the hydrochloric acid.—M. **Zeil**: The ascensional movements of the earth's crust and the anomalies of gravity.—G. **Denizot**: The lower peneplain of the Paris basin.—R. **Abrard**: A layer of eruptive rocks at Souk el Arbâa du R'Arb (Western Morocco).—V. **Bjerknes**: The relation between the movements and temperatures of the upper layers of the atmosphere.—L. **Besson**: The primitive form of atmospheric ice.—C. E. **Brazier**: The variation of the indications of the Robinson and Richard anemometers as a function of the inclination of the wind.—A. **Guilliermond**: The figured elements of the cytoplasm.—J. D. **d'Oliveira**: The transmission of fasciation and dichotomy as a result of the grafting of two Portuguese vines.—J. **Magrou**: The immunity of annual plants towards symbiotic fungi.—J. E. **Abelous** and L. C. **Soula**: The cholesterinogenic function of the spleen.—J. L. **Dantan**: Oyster beds: their development, classification, and exploitation.

March 15.—M. Henri Deslandres in the chair.—G. **Humbert**: The groups of M. Bianchi.—Em. **Bourquelot** and M. **Bridel**: The detection and characterisation of glucose in plants by a new biochemical method. The production of methyl glucoside by the action of emulsin forms the basis of the new method proposed.—MM. **d'Arsonval**, **Bordas**, and **Touplain**: The electrical purification of air.—G. **Gouy**: Gaseous currents in the interior of the sun.—Ch. **Nicolle**, A. **Cuénod**, and G. **Blanc**: The experimental reproduction of trachoma (granular conjunctivitis) in the rabbit.—M. Léon Lindet was elected a member of the section of rural economy in succession to the late Th. Schlœsing, and Sir Joseph Larmor a correspondant for the section of geometry in succession to the late M. Liapounoff.—B. **Gambier**: Applicable surfaces.—Ch. **Rabut**: The group of plane transformations in which all right lines remain right.—A. **Châtelet**:

Abelian bodies of the first degree.—H. **Villat**: The variable movement of an indefinite fluid with streamlines in presence of a solid body.—R. **Thiry**: A problem of hydrodynamics admitting an infinity of solutions.—E. **Belot**: Dichotomic classification of all stars with the hypothesis of their formation by cosmic shock.—Ad. **Braly**: A new, simple, and rapid method for collecting and characterising the sublimates produced by metalloids and metals volatilised by the blowpipe. Two flames are used, alcohol and paraffin, to secure different temperatures of volatilisation, and the sublimates are received on clear mica sheets.—O. **Mengel**: Two ancient lines of beach at Roussillon: their relations with two Glacial periods.—H. **Hubert**: Granitic rocks associated with the diabases of the Doualé massif (Haut-Sénégal and Niger).—J. **Rouch**: The height of sea-waves. The Richard statoscope was used in these measurements; 1 mm. on the scale of the instrument corresponded to about 0·5 metre variation in height. The greatest wave-heights were observed on January 28, 1910, and gave numerous waves between 4 and 5 metres, forty above 6 metres, twenty above 7 metres, nine above 8 metres, five above 9 metres, and one of 10·5 metres. Waves of a greater height than 10 metres are rare in the Atlantic and the southern seas.—P. **Bugnon**: The origin of the transverse liberoligneous bundles forming a network at the nodes of the Gramineæ.—F. **Morvillez**: The liberoligneous apparatus of the leaves of Betulaceæ, Corylaceæ, and Castaneaceæ.—L. **Blaringhem**: The production by traumatism of a new form of maize, *Zea Mays*, var. *polysperma*.—J. **Barlot**: The determination of poisonous varieties of Amanita by colour reactions. The colour reactions of numerous fungi with sulphuric acid and potash solution are detailed. Three very poisonous varieties give a positive "hæmo-reaction" with a mixture of fresh blood and potassium ferricyanide.—R. **Cambier**: The purification of sewage by activated sludge.

Books Received.

A Text-book of Inorganic Chemistry. Vol. ix. Part i. By Dr. J. Newton Friend. Pp. xvii+367. (London: C. Griffin and Co., Ltd.) 18*s*.

Grundzüge der systematischen Petrographie auf genetischer Grundlage. By Dr. W. Hommel. Erster Band: Das System. Pp. xii+174+5 Tafel. (Berlin: Gebrüder Borntraeger.) 22 marks.

Mrs. Warren's Daughter. By Sir Harry Johnston. Pp. xi+402. (London: Chatto and Windus.) 7*s*. 6*d*. net.

Recent Developments in European Thought. Edited by F. S. Marvin. Pp. 306. (London: Oxford University Press.) 12*s*. 6*d*. net.

A Junior Course of Practical Zoology. By the late Prof. A. M. Marshall and Dr. C. H. Hurst. Ninth edition. Revised by Prof. F. W. Gamble. Pp. xxxvi+517. (London: J. Murray.) 12*s*. net.

Lectures on the Theory of Plane Curves. By S. Ganguli. Part i. Pp. x+138. Part ii. Pp. xiii+139-350+diagrams. (Calcutta: University of Calcutta.)

Applied Aerodynamics. By G. P. Thomson. Pp. xx+292. (London: Hodder and Stoughton, Ltd.) 42*s*. net.

On the Interpretation of Phenomena of Phyllotaxis. (Botanical Memoirs, No. 6.) By A. H. Church. Pp. 58. (London: Oxford University Press.) 3*s*. 6*d*. net.

Half-past Twelve: Dinner Hour Studies for the Odd Half-Hours. By G. W. Gough. Pp. vi+77. (London: Sells, Ltd.) 1*s*.

Utilisation des Algues Marines. By Prof. C. Sauvageau. Pp. vi+394. (Paris: O. Doin.) 3.50 francs.

Results of Meridian Observations of Stars made at the Royal Observatory, Cape of Good Hope, in the Years 1909-1911. Ppp. xx+206. (London: H.M.S.O.) 20*s*. net.

Fundamental Catalogue of 1293 Stars for the Equinox 1900 from Observations made at the Royal Observatory, Cape of Good Hope, during the Years 1905-1911. Pp. xlvi+27. (Edinburgh: H.M.S.O.) 5*s*.

Cape Astrographic Zones. Vol. iii. Catalogue of Rectangular Co-ordinates and Diameters of Star-Images derived from Photographs taken at the Royal Observatory, Cape of Good Hope. Zone 43°. Pp. xxxvii+443 (Edinburgh: H.M.S.O.) 15*s*.

Annals of the Cape Observatory. Vol. viii. Part iv. Results of Meridian Observations of the Sun, Mercury, and Venus made at the Royal Observatory, Cape of Good Hope, in the Years 1907 to 1914. Pp. 93. (Edinburgh: H.M.S.O.) 3*s*.

The Use of Low-Grade and Waste Fuels for Power Generation. By J. B. C. Kershaw. Pp. x+202. (London: Constable and Co., Ltd.) 17*s*. net.

Colloids in Biology and Medicine. By Prof. H. Bechhold. Translated, with Notes and Emendations, by Prof. J. G. M. Bullowa. Pp. xiv+464. (London: Constable and Co., Ltd.) 31*s*. 6*d*. net.

Bygone Beliefs: Being a Series of Excursions in the Byways of Thought. By H. S. Redgrove. Pp. xvi+205+32 plates. (London: W. Rider and Son, Ltd.) 10*s*. 6*d*. net.

Macmillan's Graphic Geographies: The British Empire. By B. C. Wallis. Pp. 32. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

The Nursery-Manual: A Complete Guide to the Multiplication of Plants. By L. H. Bailey. Pp. xi+456+xii plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 13*s*. net.

A Theory of the Mechanism of Survival: The Fourth Dimension and its Applications. By W. W. Smith. Pp. 196. (London: Kegan Paul and Co., Ltd.) 5*s*. net.

Roses: Their History, Development, and Cultivation. By Rev. J. H. Pemberton. Second edition. Pp. xxiv+334. (London: Longmans and Co.) 15*s*. net.

A Short Course in College Mathematics. By Prof. R. E. Moritz. Pp. ix+226. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10*s*. 6*d*. net.

Diary of Societies.

THURSDAY, APRIL 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—S. Skinner: Ebullition and Evaporation.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir George C. Buchanan: The Ports of India: Their Administration and Development.

LINNEAN SOCIETY, at 5.—Capt. F. Kingdon Ward: Natural History Exploration on the North-east Frontier of Burma.—R. Paulson: Exhibition of Lantern-slides illustrating Definite Stages in the Sporulation and Gonidia within the Thallus of the Lichen *Evernia prunastri*, Ach.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

INSTITUTION OF MINING AND METALLURGY (Annual General Meeting) (at Geological Society), at 5.30.—F. Merricks: The Mineral Production of the Empire (Presidential Address).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Prof. W. Ripman: Spelling Reform.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Dr. C. V. Drysdale: Modern Marine Problems (Kelvin Lecture).

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—J. Weir French: The Unaided Eye, Part III.—R. R Walls: The Rock Crystal of Brazil.

CHEMICAL SOCIETY, at 8.—I. Masson and R. McCall: The Viscosity o Nitrocellulose in Mixtures of Acetone and Water.—S. S. Bhatnagar: Studies in Emulsion. Part I. A New Method for Determining Inversion.—W. H. Gibson and R. McCall: (1) The Influence of Nitroglycerine on the Viscosity of Solutions of Nitrocellulose in Ether-alcohol. (2) The Viscosity of Solutions of Nitrocellulose in Ether-alcohol.—W. K. Slater: Experiments on the Preparation of Isonitroso-derivatives.—C. S. Salmon: Direct Experimental Determination of the Concentration of Potassium and Sodium Ions in Soap Solutions and Gels.—W. C. McC. Lewis: Studies

in Catalysis. Part XIII. Contact Potentials and Dielectric Capacities of Metals, in relation to the Occlusion of Hydrogen, and Hydrogenation.—C. S. Garnett: Colouring Matters of Red and Blue Fluorspar.—Miss P. V. McKie: Determination of Nitroform by Potassium Permanganate.—J. L. Simonsen: (1) The Constituents of Indian Turpentine from *Pinus longifolia*. Part I. (2) Note on the Constituents of *Morinda citrifolia*. (3) Syntheses with the aid of Monochloromethyl Ether. Part IV. The Condensation of Ethyl Benzyl Sodiomalonate and Monochloromethyl Ether.

FRIDAY, APRIL 16.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

CONCRETE INSTITUTE, at 6.—E. Fiander Etchells: Submission of Plans to Local Authorities.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at Faraday House), at 7.—J. Scott-Taggart: The Vacuum Tube as a Transmitter and Receiver of Continuous Waves.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—J. E. Baty and Others: Discussion on Planing *v.* Milling.

TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.—F. R. Wade: Labour Unrest—Its Causes and its Cure.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Sir Ernest Rutherford: Development of Radiology (Mackenzie Davidson Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. H. Maxwell Lefroy: The Menace of Man's Dispersal of Insect Pests.

SATURDAY, APRIL 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Eccles: The Thermionic Vacuum Tube as Detector, Amplifier, and Generator of Electrical Oscillations.

MONDAY, APRIL 19.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—G. H. Ayres: Group *versus* Individual Driving.

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Rosenhain: Aluminium and its Alloys (Cantor Lecture).

SURVEYORS' INSTITUTION, at 8.—C. B. Fisher: Some Problems connected with Agricultural Policy.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Flight-Commander G. M. Dyott: An Air-Route Reconnaissance from the Pacific to the Amazon.

TUESDAY, APRIL 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Major G. W. C. Kaye: Recent Advances in X-ray Work.

ROYAL STATISTICAL SOCIETY, at 5.15.—Dr. T. H. C. Stevenson: The Fertility of various Social Classes in England and Wales from the Middle of the Nineteenth Century to 1911.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Sir Dugald Clerk: Fuel Conservation in the United Kingdom (James Forrest Lecture).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—G. F. Robertshaw: Methods of Examination of Lubricating Oils.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—Dr. C. E. K. Mees and A. H. Nietz: The Theory of Development.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—J. Darch and Others: Discussion on the Lighting of Churches.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—R. G. Brown: The Races of the Chindwin, Upper Burma.

ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Annua General Meeting.

WEDNESDAY, APRIL 21.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Rev. Father B. Vaughan Modern Patriotism.

ROYAL SOCIETY OF ARTS, at 4.30.—Air-Commodore E. Maitland: The Commercial Future of Airships.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. A. Chaplin: The History of Medical Education at the Universities of Oxford and Cambridge.—Mme. Panayotatou: Baths and Bathing in Ancient Greece.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Royal Observatory, Greenwich: Polar Night-Sky Recorder.—Lieut. N. L. Silvester: Local Weather Conditions at Mullion, Cornwall.—J. E. Clark: The Surrey Hailstorm of July 16, 1918.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—J. W. D. Robinson: The Devonian of Ferques (Bas-Boulonnais).—E. S. Cobbold: The Cambrian Horizons of Comley (Shropshire) and their Brachiopoda, Pteropoda, Gasteropoda, etc.

ROYAL MICROSCOPICAL SOCIETY, in conjunction with the OPTICAL SOCIETY and the FARADAY SOCIETY (at the Royal Microscopical Society), 7 to 10.—General Discussion on The Mechanical Design and Optics of the Microscope.—Prof. J. Eyre: Opening Remarks.—J. E. Barnard: A General Survey.—A. *The Mechanical Design of the Microscope.* (*a*) General. Prof. F. J. Cheshire: The Mechanical Design of Microscopes.—C. Beck: The Standard Microscope.—F. W. Watson Baker: Progress in Microscopy from a Manufacturer's Point of View.—P. Swift: A New Microscope.—(*b*) Metallurgical. Dr. W. Rosenhain: The Metallurgical Microscope.—Prof. C. H. Desch: The Construction and Design of Metallurgical Microscopes.—E. F. Law: The Microscope in Metallurgical Research.—H. M. Sayers: Illumination in Micro-metallography.—(*c* Petrological. Dr. J. W. Evans: The Requirements of a Petrological Microscope.—B. *The Optics of the Microscope.* Prof. A. E. Conrady: Microscopical Optics.—Dr. H. Hartridge: An Accurate Method of Objective Testing.—H. S. Ryland: The Manufacture and Testing of Microscope Objectives.—F. Twyman: Interferometric Methods.

THURSDAY, APRIL 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—S. Skinner: The Tensile Strength of Liquids.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. W. E. Dalby: Researches on the Elastic Properties and the Plastic Extension of Metals.—H. W. Hilliar: Experiments on the Pressure Wave thrown out by Submarine Explosions.—E. F. Armstrong and T. P. Hilditch: A Study of the Catalytic Action at Solid Surfaces. III. The Hydrogenation of Acetaldehyde and the Dehydrogenation of Ethyl Alcohol in the Presence of Finely Divided Metals. IV. The Interaction of Carbon Monoxide and Steam as conditioned by Iron Oxide and by Copper.—Dr. T. R. Merton: The Structure of the Balmer Series of Hydrogen Lines.—Prof. H. A. Wilson: Diamagnetism due to Free Electrons.

FRIDAY, APRIL 23.

PHYSICAL SOCIETY, at 5.—M. C. E. Guillaume: The Anomaly of the Nickel-Iron Alloys: Its Causes and its Applications (Guthrie Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—The late W. J. Lineham: (1) The Hardening of Screw-Gauges with the least Distortion in Pitch (referring to Water Hardening). (2) The Hardening of Screw-Gauges with the least Distortion in Pitch (referring to Oil Hardening).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Israel Gollancz: Shakespeare's Shylock and Scott's Isaac of York.

SATURDAY, APRIL 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Eccles: The Thermionic Vacuum Tube as Detector, Amplifier, and Generator of Electrical Oscillations.

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